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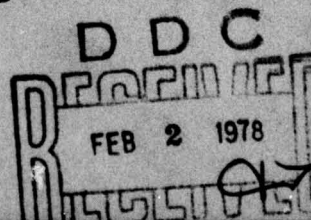
ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT

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**Comparative Study of Regulations
on Standards of Medical Fitness
for Flying Duties in Nine Air Forces
Covering Seven Countries of the
North Atlantic Treaty Organization**

by
E. Evrard



NORTH ATLANTIC TREATY ORGANIZATION



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COMPARATIVE STUDY OF REGULATIONS ON STANDARDS OF MEDICAL
FITNESS FOR FLYING DUTIES IN NINE AIR FORCES COVERING SEVEN
COUNTRIES OF THE NORTH ATLANTIC TREATY ORGANIZATION

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INTRODUCTION

→ This comparative study was undertaken at the request of the AGARD Aerospace Medical Panel. It covers current standards for assessing fitness for flying duties in the Armed Forces of seven of the North Atlantic Treaty countries.

The following ^{applicable} nine sets of regulations provided the material for this study: *They were those of the*

- the regulations applicable to the flying personnel of the Belgian Armed Forces;
- the regulations applicable to the flying personnel of the Canadian Armed Forces; *west German and*
- the regulations applicable to the flying personnel of the French Armed Forces;
- the regulations applicable to the Armed Forces of the Federal Republic of Germany;
- the regulations applicable to the flying personnel of the Norwegian Air Force; *the*
- the regulations applicable to Royal Air Force flying personnel; *and the*
- the regulations applicable to US Air Force flying personnel;
- the regulations applicable to US Navy flying personnel;
- the regulations applicable to US Army flying personnel. *(cont on p iii)*

For various reasons, the regulations concerning standards of fitness for flying duties applicable to military flying personnel in the other countries represented in AGARD were not available in time to be included. These regulations, most of them twenty-five years old, are at present under revision by the authorities in the countries concerned.

Although the ideal scope of such a comparative study would have been a report on all the military requirements for fitness for flying duties in force in all the NATO countries, it is believed that the very many real gaps in the present report will not greatly detract from its practical conclusions and their application.

For ease of comparison, the subjects covered have been divided into chapters, each of which is devoted to a major function or a major system. This sub-division corresponds moreover to the conventionally recognised specialist fields of medicine and, in its broad outlines, to the Table of Contents of the majority of the national regulations.

The author is well aware that all the regulations are careful to point out that the information they contain is mainly for purposes of guidance, and provides the examining medical officer with *directives* rather than *mandatory requirements*. Regulations on standards of fitness can obviously never cater for everything nor forbid the exercise of the medical officer's clinical sense or his common sense. It is nevertheless true that examination results which are expressed as calculated values are significant only if they entail categorically either fitness or unfitness, as specifically indicated in terms of these numerical values.

In his comments and assessments included in the chapters which follow, the author has refrained from consideration of what, in his view, is a hard and fast rule, and what is, in fact, a directive which is capable of a certain degree of flexibility in its interpretation.

It is also important to stress that a number of minor details which are found in some regulations and not in others have not been noted or commented on. They would have made the report excessively tedious and complicated without meeting the practical objectives fixed for the author by the Aerospace Medical Panel, namely:

- (a) to provide medical officers in each of the North Atlantic Treaty countries with the main texts, recommendations and provisions applicable to military aircrew in the other allied countries and also to provide them with information to enable them to take a decision in borderline cases and in matters which may give rise to dispute;
- (b) to initiate a review of the ideas and doctrines which for several decades have formed the basis for the conduct of tests, some which are still awaiting scientific justification for their use in assessing medical fitness for flying duties;
- (c) to promote as far as possible some standardization in the method of conducting examinations, in interpreting their results and in the consequent decisions in regard to fitness for flying duties in the Air Forces of all the North Atlantic Treaty countries.

Such an attempt at standardization must obviously, however, take into account the particular features of anatomical structure, manner of life, national habits, climatic conditions and numerous other factors specific to each country.

CHAPTER I

GENERAL PHYSICAL CONSTITUTION

A. MILITARY REGULATIONS

All the military regulations lay down the following requirements which flying personnel must satisfy both in the initial medical examination and in the subsequent periodic examinations, irrespective of the type of flying duties performed:

- (a) the subject must be robust and well set up, although there is no reason for requiring particularly marked development of the musculature;
- (b) he must be free from any sequelae of wounds, diseases or surgical interventions, and from any congenital or acquired abnormalities which might hinder or interfere with the performance of his duties, particularly in the event of prolonged or difficult flying, and at high altitudes.

B. ICAO REGULATIONS

With regard to civil flying personnel the ICAO regulations have similar provisions: an applicant for a flying licence must be free from:

- (a) any abnormality, whether congenital or acquired, or
- (b) any active, latent, acute or chronic disability, or
- (c) any wound, injury or sequelae of an operation such as would entail a degree of functional incapacity which is likely to interfere with the safe handling of an aircraft at any altitude throughout a prolonged or difficult flight.

C. BIOMETRIC AND SKELETAL REQUIREMENTS

(a) *The French Military Regulations provide for two standards:*

1. *Standard A*

This standard is required for fitness to fly an aircraft equipped with an ejection seat.

(1) *Overall height*

The subject's overall height must be 1.60 metre or more. Weight must be in a suitable proportion to height.

(2) *Segmental measurements*

The segmental measurements must be within or equal to the following values:

- height of body, seated: 0.80 to 1 metre;
- useful length of upper limb: 0.60 to 0.8 metre;
- length of thigh: 0.50 to 0.65 metre;
- length of leg: 0.45 to 0.60 metre.

(3) *Examination of the spine and other musculoskeletal structures*

Any major congenital or acquired abnormality of the spine, and any important disorder in posture result in unfitness for flying duties in aircraft equipped with ejection seats:

- scoliosis, when the scoliotic angle is more than 15°. If the angle is less than 16°, fitness is only acceptable when the subject has a good musculature;
- major transitional abnormalities: total dislodgment of the "pilot" vertebra, lumbar scoliosis with an angle greater than 15° and dislodgment, important asymmetry;
- major kyphosis and lordosis;

- spondylolysis (isthmic lysis) with spondylolisthesis presenting a slipping exceeding 1 centimetre ;
- congenital block with functional or dynamic troubles;
- epiphysosis, if important postural troubles or major morphological abnormalities of more than two vertebral bodies (cuneiform deformity or flattening) are present;

A simple pelvic imbalance is not in itself a cause of unfitness. Some minor abnormalities (anterior cuneiform wedge, cuneiform vertebrae, anterior retromarginal hernia) are acceptable.

Standard A applies to:

- candidate pilots - all classes;
- candidate navigators, bomb-aimers, radar operators;
- fighter, reconnaissance and bomber pilots (jet aircraft);
- navigators, bomb-aimers, radar operators.

2. *Standard B*

This standard does not include fitness for ejection seats.

(1) *Overall height*

The overall height of the candidates must be between 1.60 and 1.96 metre. For female flight attendants the minimum required height is 1.55 metre. Weight must be in a suitable proportion to height.

(2) *Segmental measurements*

Segmental measurements are not taken into account.

(3) *Examination of the spine and other musculoskeletal structures*

Any major, congenital or acquired abnormality of the spine and any important disorder in posture result in unfitness for flying. However, the following spinal abnormalities are acceptable:

- scoliosis when the scoliotic angle is greater than 15° and smaller than 25°;
- scoliosis with a pelvic imbalance greater than 2 cm and a scoliotic angle smaller than 25°;
- minor kyphosis and lordosis;
- spondylolysis (isthmic lysis) without spondylolisthesis or with spondylolisthesis if the slipping is smaller than 1 cm;
- epiphysosis or sequelae of epiphysosis, if they are of minor importance;
- some minor abnormalities (anterior cuneiform wedge, cuneiform vertebrae, anterior retromarginal hernia).

This standard B applies to:

- candidate pilots of transport aircraft;
- candidate navigators of transport aircraft;
- candidate flight engineers;
- candidate female flight attendants;
- candidate military reserve pilots;
- candidate air gunner observers;
- pilots of transport aircraft;
- bomber pilots (conventional type aircraft);
- pilots of twin-engined communications aircraft;
- helicopter pilots;
- pilots of liaison aircraft;
- pilots of single-engined light support aircraft;
- military reserve pilots;
- ab initio flying training instructor pilots;
- navigators of transport aircraft;
- radio navigators;
- aircraft radio operators;
- air gunner observers;
- flight refuellers;
- flight engineers;
- female flight attendants;
- candidates for flying personnel and aircrew of the light aviation of the Army and of the Gendarmerie.

(b) United States Air Force (USAF) Regulations

These contain provisions applicable to all classes of flight personnel (Classes I, IA, II, III).

The following are disqualified:

1. For males, height less than 64 inches (162.5 cm), or more than 76 inches (193 cm). For pilot training, a sitting height greater than 39 inches (99 cm) is also a disqualifying factor.
2. For females, height less than 60 inches (152.4 centimetres), or more than 72 inches (182.9 centimetres). These subjects are solely applicants for Class III (flight nurses).
3. Weight, in relation to height and age, which is outside the regulation limits fixed for men and women (see following Tables).

TABLE I

Weight Table

(1) Males

Height (in inches)	Weight (in pounds)							
	Minimum	Normal	Maximum					
			18-20 years	21-25 years	26-30 years	31-35 years	36-40 years	41 years and over
60	100	122	146	150	153	157	160	164
61	102	124	149	153	155	159	163	166
62	103	126	151	155	158	161	165	169
63	104	128	155	158	160	164	168	171
64	105	131	159	160	164	168	171	175
65	106	135	163	165	169	173	176	180
66	107	139	166	170	174	178	181	185
67	111	143	171	175	179	183	186	190
68	115	147	176	180	184	188	191	195
69	119	151	181	185	189	193	196	200
70	123	155	186	190	194	198	201	205
71	127	159	191	195	199	203	206	210
72	131	164	196	201	205	209	213	216
73	135	169	201	208	211	215	219	223
74	139	174	206	214	218	221	226	229
75	143	179	211	220	224	228	231	235
76	147	184	216	226	230	234	238	241
77	151	189	221	232	236	240	244	248
78	153	194	226	239	242	246	250	254
79	157	199	231	245	248	252	256	259
80	161	204	236	251	254	258	262	265

Note: The above-mentioned weights are based on average body build. The maximum weight was calculated by adding two standard deviations (15%). When a determination of the lean body mass indicates that the fatty tissues in a subject's body are more than 32% of his lean body mass, the Tables no longer apply.

TABLE 2

Weight Table

(2) Females

Height (in inches)	Weight (in pounds)					
	Minimum	Ideal	Maximum			
			18-20 years	21-30 years	31-40 years	41 years and over
58	87	90-103	115	116	118	120
59	89	92-106	118	119	121	123
60	92	95-109	121	123	125	127
61	95	98-112	125	126	128	130
62	97	101-115	128	129	131	133
63	100	104-118	131	132	135	137
64	103	107-121	134	136	138	140
65	106	110-124	138	139	141	143
66	108	113-127	141	142	145	147
67	111	115-130	144	146	148	150
68	114	119-133	147	149	152	154
69	117	121-135	151	152	155	157
70	119	124-139	154	156	158	160
71	122	127-142	157	159	162	164
72	125	130-145	160	162	165	167

(c) United States Navy Regulations

These contain the following provisions, applicable to all classes of flying personnel in the US Navy.

1. The minimum and maximum height compatible with fitness for flying duties are respectively 64 inches (162.5 centimetres) and 78 inches (198.12 centimetres).
2. The sitting height must be between 32 inches (81.3 centimetres) and 41 inches (104.1 centimetres).
3. The buttock-leg length must not be less than 36 inches (91.44 centimetres) nor more than 50 inches (127 centimetres).
4. Weight must meet certain standards, the maximum and minimum weight being fixed according to height and age. There is great similarity with the USAF Tables.

However, even though a subject's weight does not exceed the maximum laid down, he will not be passed as fit if the medical examiner considers that the weight, in relation to body structure and musculature, constitutes obesity of such a degree as to interfere with the satisfactory performance of his flying duties.

(d) United States Army Regulations

These contain the following provisions, applicable to all classes of flying personnel in the US Army.

1. Height

Subjects whose height is less than 64 inches (162.5 centimetres) or more than 76 inches (193 centimetres) are not acceptable for flying duties.

2. Weight

The following are assessed as unfit for flying duties:

- (1) subjects of the male sex whose weight is outside the maximum or minimum limits specified in a regulation weight table;
- (2) subjects of the female sex whose weight is outside the maximum or minimum limits specified in a regulation weight table. The maximum weight must never exceed 180 pounds (81.650 kilograms).

However, even though a subject's weight does not exceed the maximum weight for his height, age and sex, he will not be assessed as fit if the medical examiner considers that such weight, when related to the body structure and musculature, might be detrimental to the flying efficiency or endanger the health of the individual if he continues to remain a member of the flying personnel.

The weight tables referred to at (1) and (2) above are not exactly the same as those in the USAF regulations. For subjects of the male sex, the minimum weight is similar to that in the USAF table, but the maximum permissible weight is lower than that for the USAF. The maximum difference may be as much as 27 pounds for subjects who are 1.93 metre tall, and whose age is between 36 and 40 years. In the case of subjects of the female sex, the reverse occurs: the maximum weight compatible with fitness is higher in the US Army than in the USAF. Differences are between 20 and 25 pounds (9 to 12 kilograms).

(e) Canadian Armed Forces Regulations

These contain the following requirements:

1. *Height*

The minimum and the maximum height for entry into the Armed Forces for males is respectively 158 centimetres and 194 centimetres, and for females, respectively 152 and 184 centimetres. In addition, those applying for acceptance as flying personnel must satisfy the following segmental measurements, in connection with suitability for use of the ejection seat:

- height of body, seated: 102 centimetres maximum,
- length of thigh: 67 centimetres maximum.

2. *Weight*

Weight must be normal in relation to height.

For each of the two sexes, a table indicates against each height measurement the ideal weight, the minimum and the maximum weight compatible with fitness for flying duties, at the initial examination.

Generally speaking, the maximum weight is less than that in the USAF table and does not take account of age.

(f) Regulations for the Armed Forces of the Federal Republic of Germany

Very precise requirements, with figures, are laid down for height and weight.

1. *Height*

The height must be between 162 and 193 centimetres. Two segmental measurements, the sitting height of the body and the thigh length, must be taken into account for fitness for flying duties in any type of aircraft equipped with an ejection seat. These segments must be within a maximum value and a minimum value, variable according to the type of aircraft. These values are given in Table 3 overleaf.

2. *Weight*

The body weight must be within the maximum and minimum limits laid down in a table which shows a great similarity with the USAF table quoted above.

But, for fitness for flying duties in aircraft equipped with an ejection seat, the weight must be within a maximum limit and a minimum limit which depend on the type of aircraft. These values are given in Table 3 overleaf.

(g) Royal Air Force Regulations (United Kingdom)

1. *Height, and Leg Length*

No minimum or maximum standards are laid down as mandatory requirements in the text of the regulations on fitness for flying duties, except for air loadmaster's duties when the height is required to be between 157.5 and 190.5 cm.

The RAF authorities consider that the size of cockpits and gun turrets imposes certain restrictions, but that it is for the Executive to decide whether a person's size makes him unfit to perform any particular aircrew function.

In addition to measurement of a subject's height, the regulations also describe the method of measuring leg length.

TABLE 3

**Body Weight, Sitting Height and Thigh Length for
Fitness for Flying in Aircraft Equipped with Ejection Seats**

<i>Aircraft</i>	<i>Body Weight (naked subject)</i>		<i>Sitting Height</i>		<i>Thigh Length</i>	
	<i>Minimum</i>	<i>Maximum</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Minimum</i>	<i>Maximum</i>
F-104 F 4	58.65 kg	96.0 kg	85.8 cm	96.5 cm	55.7 cm	64.5 cm
G 91	60.1 kg	91.1 kg	85.8 cm	96.5 cm (1)	55.7 cm	64.5 cm
T 37	—	—	—	100.3 cm	—	69.8 cm
T 38	—	—	—	99.0 cm	—	—
Alpha-jet	56.6 kg	97.3 kg	86.7 cm	101.1 cm	55.2 cm	67.4 cm
MRCA	56.6 kg	97.3 kg	86.7 cm	101.1 cm	55.2 cm	67.4 cm
S 3 Viking	61.5 kg	96.5 kg	86.6 cm	99.0 cm	56.6 cm	66.5 cm

(1) With helmet, the maximum height is 103.1 cm.

These values are not valid in case of using a partial pressure suit and a pressurised helmet.

2. *Weight*

A table shows, for persons of both sexes, the relationship between height and normal weight.

If the applicant is overweight, the medical examiner must ascertain whether there are any endocrine disorders. Obesity is considered to exist when a person's weight exceeds by 25% or more the accepted average weight in relation to height and age, and taking into account body structure and musculature. The final decision will depend on the presence or absence of clinical abnormalities such as hypertension or endocrine disorders. If an applicant is underweight, all the possible causes for this condition, particularly hyperthyroidism, must be sought in past medical history and by clinical examination.

3. *Body Build*

Although body build is of some value when considering the general capabilities of an individual, this factor is not sufficiently important or constant to affect the assessment decision, unless there is a serious difference between the body build of the subject and the normal for his age.

(h) **Belgian Military Regulations**

These are very similar to the RAF regulations.

1. *Height*

The height of applicants for aircrew duties and of serving aircrew must be within the maximum and minimum limits laid down by the military medical authorities in relation to the dimensions of the cockpit in aircraft in service in the Armed Forces and after consultation with the Chief of Staff of the Forces concerned.

The regulations do not therefore include values of a mandatory nature. There are special instructions which specify the maximum and minimum limits in these matters, in relation to the characteristics of the aircraft in service.

2. *Weight*

At the time of the selection examination no candidate for aircrew duties must weigh more than 95 kg, except air gunners, the maximum weight for whom is fixed at 80 kg.

Excessive obesity always entails rejection.

For obesity to be defined as excessive, the following three conditions must be present:

- (1) the weight exceeds by 15 kg the number of centimetres of the height beyond 100 when the height is less than 165 cm;
the weight exceeds by 20 kg the number of centimetres of the height beyond 100 when the height is 165 cm or more;
- (2) the maximum abdominal circumference is considerably greater than the thoracic circumference;
- (3) shortness of breath after moderate exertion.

3. *Constitutional Debility*

If the subject exhibits characteristics of constitution debility, that is, if he is suffering from any pathological defects or predispositions, which though insufficient in themselves to justify his non-acceptance, indicate by their number and clinical significance some inadequacy in regard to the development of the body or some debility of the constitutional condition which is incompatible with the requirements for military service, he must be rejected.

4. *Lack of Robustness*

A lack of robustness can be gauged from the results of the morphological examination and more particularly those of the *clinical* examination. The examiner will pay special attention to the *functional* aspect of the circulatory and respiratory organs. Account will be taken of the results of an *endurance test* which is specified for the purpose of determining cardiovascular tolerance to *prolonged* and *exhausting effort*. As will be seen later (Chapter IV), this is the Harvard step-test, lasting for five minutes.

(i) **Norwegian Air Force Regulations**

These are similar to the USAF regulations.

Note

The Swiss Air Force regulations specify that applicants must be between 1.60 and 1.90 metre tall.

D. **COMMENTS**

(a) The biometric and skeletal requirements in the regulations clearly involve body build factors, but they also take into consideration in particular such factors as ensuring that the subject's size is adapted to the dimensions of aircraft cockpits and that he meets the requirements for the use of the ejection seat.

(b) The requirements found in all the regulations are based on the traditional concepts of *height* and *weight*.

(c) In addition, various regulations have introduced *segmental measurements*.

1. Measurements of the sitting height and measurement of thigh length are found in the *French, German* and *Canadian* regulations.

2. Measurement of the useful length of the upper limb and measurement of leg length are included in the *French* regulations, in addition to the two segmental measurements quoted in 1.

3. The USAF and US Navy regulations, and also those of Norway, prescribe, as segmental measurement, the sitting height. The buttock-leg length is specific to the US Navy regulations.

4. The UK and the Belgian regulations contain no precise and mandatory requirements in this connection, nor any specific requirements for overall height. They refer to decisions which are made by the Executive. This indicates that requirements do exist, but that the authority wishes to keep them fairly flexible so that they can be adapted, if necessary, to suit the various types of aircraft in service.

5. The US Army regulations do not mention any requirement for segmental measurements.

(d) The numerical values of the requirements for overall height and segmental measurements can be *classified* as follows:

1. *Minimum Height*

160 cm: French Armed Forces

162 cm: US Air Force, US Navy, US Army, the Air Forces of the Federal Republic of Germany and Norway

not specified: RAF and Belgian Air Force. Previous RAF and Belgian Air Force regulations do, however, quote 162 cm as the minimum height.

not specified: in the Canadian regulations for flight personnel, but minimum height for acceptance for military service is 158 cm.

2. Maximum Height

198 cm:	US Navy
196 cm:	French Armed Forces (Standard B)
194 cm:	Canadian Air Force
193 cm:	USAF, US Army, Air Forces of the Federal Republic of Germany and Norway
not specified:	French Air Force (Standard A)
not specified:	RAF and Belgian Air Force
In previous regulations it was fixed at 193 cm.	

3. Segmental Measurements

(1) Height of body, sitting

France:	between 80 and 100 cm
USAF:	99 cm maximum
Norway:	99 cm maximum
US Navy:	between 81 and 104 cm
Canada:	102 cm maximum
Federal Republic of Germany:	maximum between 96.5 and 101.1 cm, according to the types of aircraft
United Kingdom:	not specified
Belgium:	not specified
US Army:	not specified

(2) Length of thigh

France:	between 50 and 65 cm
Federal Republic of Germany:	maximum between 64.5 and 69.8 cm according to the types of aircraft
Canada:	67 cm maximum

4. Weight

All the regulations require weight to be in suitable proportion to height.

They all contain tables – different for each sex – showing the ideal or normal weight according to height and age, as well as the maximum and minimum weights compatible with fitness for air duties.

It must be noted that the German regulations have introduced the concept of a minimum weight and a maximum weight, specific to each type of aircraft equipped with an ejection seat.

Points of difference exist between these various tables. Since the concept of obesity has no precise limits, an element of arbitrariness is therefore inevitable when assessing what is acceptable and what is not acceptable. The results of a *clinical* examination are however required in several regulations in order to avoid the possibility that a decision would be based solely on morphological data.

5. Practical Conclusions

The various regulations agree on the manner of evaluating the concept of *weight* normality. The same applies to the minimum weight. They differ fairly widely in regard to the maximum weight. It would seem that a sensible approach to this concept should be made by divesting it of any hard and fast rules and tempering it by looking for *clinical factors* in order to assess the functional effects of obesity.

For aircrew who must fly in aircraft equipped with an ejection seat, the German regulations have introduced the concept of a maximum weight and a minimum weight, depending on the type of aircraft. Presently, such requirements are only met in German regulations. It does not seem that the maximum weights are such that they are a frequent or excessive cause of unfitness for flying in aircraft equipped with an ejection seat. A research on the practical consequences of this specific point of the German regulations would be interesting.

With regard to *overall height*, because of the requirements dictated by adaptation to the size of the cockpit in combat aircraft and to the ejection seat, there are very few differences in the various regulations. For combat pilots and navigators, there is general agreement that the height should be between 162 and 193 cm. Three Air Forces only differ in regard to the maximum height:

- US Navy Aviation (198 cm);
- French Armed Forces (196 cm for Standard B);
- the Canadian Air Force (194 cm).

In the case of the French Armed Forces, subjects who are acceptable under Standard B are pilots and navigators of transport aircraft, communications or bomber aircraft (conventional type), pilots of light support aircraft and helicopter pilots.

Presumably the aircrew in the US Navy and the Canadian Air Force, whose height exceeds 193 cm, are engaged on these same duties. An additional study in this connection would be useful.

With regard to *minimum height*, the only exception is quoted in the French regulations (160 cm).

It would be of interest to find out whether this group of personnel, with a height of between 160 cm and 162 cm, constitutes a large proportion of the whole of the flight personnel, whether it presents any particular difficulties during flying training and whether the subjects belonging to this group have to be barred from flying certain types of fighter aircraft.

On the question of segmental measurements the maximum values show considerable differences:

- (1) Height of body, sitting: between 96.5 cm and 104 cm
- (2) Length of thigh: between 64.5 cm and 69.8 cm.

As it appears from the German regulations, these differences find a justification in the cockpit dimensions and characteristics of the different types of fighter aircraft and training aircraft, equipped with ejection seats and presently used in the NATO Air Forces. A standardisation of the minimum and maximum limits for the height of the body in a sitting position and for the length of thigh is however very desirable. As a matter of fact, during a normal career, a pilot has to use several types of fighter aircraft. It would be regrettable that a question of segmental measurements could be a bar from piloting certain types of fighter aircraft in his own Air Force. The problem is to fix the minimum limits for some cockpit dimensions.

But, on the other hand, if the highest figures quoted concerning the segmental measurements do not raise difficulties in the cockpits of all aircraft currently in service, there is no reason for not relaxing the standards which lay down lower maximum figures. The importance of this factor could well form the subject of a special study in several Air Forces.

One interesting point should be particularly stressed. This is the introduction, in the French regulations, of the concept of skeletal abnormalities which make an applicant unfit to use an ejection seat and the skeletal abnormalities not compatible with fitness for helicopter piloting.

These concepts will be referred to again later on when discussing the examination of the musculo-skeletal system (Chapter II). It is important, however, to observe that these extremely precise data help to define very clearly the concept of unfitness for ejection, that is, unfitness to fly combat aircraft, and the concept of unfitness for flying helicopters. They take into account findings which are easily obtained from X-ray photographs of the skeleton, and are justified by the well established physiopathology of ejection and of mechanical vibrations.

The AGARD Aerospace Medical Panel could perhaps devote some attention to this original aspect of the French regulations, assess its importance in the selection of flying personnel and possibly add other abnormalities or deformities, the detrimental nature of which may have been established.

When that study had been concluded, it would then be a matter of deciding whether it would be useful or advisable to suggest to the appropriate medical authorities of the NATO Air Forces that such concepts, confined at the moment to a single Air Force, should be incorporated in the respective national regulations of the other Air Forces.

CHAPTER II

MUSCULO-SKELETAL SYSTEM

Because of its numerous practical implications, this Chapter is an extremely detailed one in all the various regulations. The following three sub-divisions will be used to classify the grounds on which aircrew or applicants must be assessed as unfit:

- (a) General,
- (b) Upper and lower limbs,
- (c) Vertebral column.

They apply both to the initial examination and to the periodic examinations. Some practical conclusions will then be drawn.

A. INITIAL EXAMINATION

(a) General

All the regulations agree in rejecting as aircrew candidates any applicants suffering from:

1. serious and incurable diseases of the bones and joints;
2. active osteoarticular diseases;
3. deformities, tumours, lesions or chronic diseases of the bones or joints resulting in functional disorders which restrict movement and prevent the wearing of a part of the equipment;
4. incurable muscular or tendinous lesions which interfere with the wearing of flying equipment or the manoeuvres required for the safe execution of flights of any kind.

Of all the regulations concerned, those laid down by the American authorities contain the greatest amount of detail when listing these causes for rejection. The other regulations devote much less space to them. In spite of the varying scope of such lists, there are in fact no differences of opinion between them, and this is a salient point.

The following is the complete text of the USAF regulations in regard to an assessment of unfitness for reasons connected with the musculo-skeletal system.

The following are causes for the rejection of candidates for flying duties:

- (1) acute, sub-acute or chronic arthritis;
- (2) chronic osteoarthritis or post-traumatic arthritis of isolated joints of more than minimal degree, which has interfered with successfully following a physically active vocation in civilian life or is likely to prevent the satisfactory performance of military duty;
- (3) established history or findings of rheumatoid arthritis;
- (4) post-traumatic arthritis of a major joint, of more than minimal degree;
- (5) active osteomyelitis or a verified history of osteomyelitis, unless inactive during the two years prior to examination and with no sequelae sufficient to interfere with function;
- (6) all types of malignant tumour of the bones or joints, or history of such a tumour;
- (7) a benign tumour of a bone or joint sufficiently large to interfere with function, or if it is progressive;
- (8) osteoporosis;
- (9) osteochondromatosis or multiple cartilaginous exostoses;
- (10) any disease or injury of any bone or joint, healed with residual deformity, rigidity, or limitation of motion so that function is impaired to such a degree as to interfere with the performance of military duty, or any congenital abnormalities causing similar interference;
- (11) any unreduced dislocation; confirmed history of recurrent dislocations or subluxations of a major joint, if not satisfactorily corrected by surgery;

- (12) instability of a major joint, if more than mild and symptomatic; or if surgery is followed by evidence of instability, weakness or atrophy; or if the candidate requires regular and frequent medical treatment;
- (13) malunited fractures, when these interfere significantly with function;
- (14) ununited fractures;
- (15) any fracture in which screws, plates or pins were used for fixation, if such fixing devices remain in place and are easily subject to traumas;
- (16) muscular paralysis, paresis, contracture or atrophy, if progressive or of sufficient degree to interfere with the performance of military duties;
- (17) demonstrable loose body in a joint (including osteocartilaginous fragments or metallic foreign objects);
- (18) severe acute or chronic sprain of a major joint with residual swelling, limitation of motion or joint instability;
- (19) synovitis with persistent swelling or limitation of motion;
- (20) chondromalacia, manifested by verified history of joint effusion, interference with function or sequelae of surgical treatment.

(b) Upper Extremity and Lower Extremity

All the regulations state that the four extremities must be functionally sound.

The pathology which affects this functional soundness is described in varying degrees of detail.

It is proposed to give two extreme examples of the type of description found:

- 1. the extremely brief comments in the French regulations referring both to the upper and the lower extremities;
- 2. the detailed description in the USAF regulations, with separate references for the upper and the lower extremities.

1. French Regulations

"Old fractures, which have united well in the correct position and provided they do not interfere with function, need not necessarily be grounds for assessing a person as unfit. The same applies to fractures which have been treated by means of osteosynthesis, provided the latter is simple and has been well tolerated for a sufficient period of time."

2. USAF Regulations

Upper extremities

The following are causes for rejection:

- (1) absence (or loss) of more than one-third of the distal phalanx of either thumb;
- (2) absence (or loss) of the distal or middle phalanges of an index, middle or ring finger of either hand, irrespective of the absence (or loss) of the little finger;
- (3) absence (or loss) of more than the distal phalanges of any two of the following fingers of either hand: index, middle or ring;
- (4) absence of any portion of the hand or upper extremity in excess of the above;
- (5) symptomatic amputation stump (neuroma, bone spur, adherent scar, or alceration);
- (6) resection of a joint other than in the fingers;
- (7) hyperdactylia;
- (8) scars and deformities of the fingers or hand which impair circulation, are symptomatic, or impair normal function to such a degree as to interfere with the satisfactory performance of military duty;
- (9) healed disease or injury of wrist, elbow or shoulder with residual weakness or symptoms of such a degree as to preclude satisfactory performance of duties;
- (10) the following limitation of movement:
 - (a) *Shoulder:* inability to extend the arm forward to 90°; inability to abduct the arm to 90°;
 - (b) *Elbow:* inability to flex the elbow to 100°; inability to extend it to 15°;
 - (c) *Wrist:* inability to achieve a total range of 15° extension plus flexion;
 - (d) *Hand:* inability to achieve pronation to the first quarter of the normal arc, or supination to the first quarter of the normal arc;
 - (e) *Fingers:* inability to clench the fist, pick up a needle, or grasp an object.

Lower extremity

The following are causes for rejection:

- (1) loss of a big toe or loss of two toes on the same foot;
- (2) amputation or absence of any portion of the foot or lower extremity in excess of that under (1);
- (3) symptomatic amputation stump (neuroma, bone spur, adherent scar or ulceration);
- (4) clubfoot, of any degree;
- (5) rigid flat foot, or spastic flat foot;
- (6) weak foot with demonstrable eversion of the foot, valgus of the heel, or marked bulging of the inner border due to inward rotation of the astragalus, regardless of the presence or absence of symptoms;
- (7) elevation of the longitudinal arch (pes cavus) if of sufficient degree to cause subluxation of the metatarsal heads and clawing of the toes;
- (8) hammer or claw toes of such a degree as to interfere with function or the wearing of military footwear;
- (9) hallux valgus, if sufficiently marked to interfere with ambulation or when accompanied by a symptomatic bunion;
- (10) bunions, if symptomatic or sufficiently large to interfere with function;
- (11) hallux rigidus, if X-ray reveals degenerative changes in the joint;
- (12) plantar warts, if symptomatic;
- (13) corns and callouses, if symptomatic or if they interfere with ambulation;
- (14) ingrowing toenails, if severe, and not remediable;
- (15) overriding of any of the toes, if symptomatic or sufficient to interfere with the wearing of military footwear;
- (16) verified history of congenital dislocation of the hip, osteochondritis of the hip (Legg-Perthes disease) or slipped femoral epiphysitis of the hip with X-ray evidence of residual deformity or degenerative changes;
- (17) verified history of dislocation of the hip within the two years prior to the examination, or X-ray evidence of degenerative changes from old hip dislocation;
- (18) difference in leg length of more than 2.5 cm (measured from the anterior superior iliac spine to the distal tip of the medial malleolus);
- (19) dislocation of semilunar cartilages or loose foreign bodies within the knee joint; history of surgical correction of same within the preceding six months; or, if more than six months have elapsed without recurrence and there is instability of the knee ligaments in the lateral or anteroposterior directions, as compared with the normal knee, or abnormalities noted in the X-ray; or if there is significant atrophy or weakness of the thigh musculature as compared with the normal side; or if there is no acceptable active motion in flexion and extension (i.e. flexion to 90° and full extension), or if there are other symptoms of internal derangement;
- (20) authentic history of physical findings of an unstable or internally deranged joint, causing disabling pain or seriously limiting function. Individuals with verified episodes of buckling or locking of the knee who have not undergone satisfactory surgical correction; or if, subsequent to surgery, there is evidence of more than mild instability of the knee ligaments in the lateral and anteroposterior directions as compared with the normal knee; or, if there is weakness or atrophy of the thigh musculature as compared with the normal side; or if the subject requires medical treatment of sufficient frequency to interfere with the performance of military duty;
- (21) chondromalacia of the patella, if there are demonstrable X-ray changes;
- (22) osteochondritis dissecans of the knee or ankle, if there are X-ray changes;
- (23) osteochondritis of the tibial tuberosity (Osgood-Schlatter disease), if symptomatic or with obvious prominence of the part and X-ray evidence of separated bone fragments;
- (24) varicose veins;
- (25) deformities of one or both lower extremities, hip, knee or ankle joint which interferes with function to such a degree as to prevent the subject from following a physically active vocation in civilian life, or which would interfere with the satisfactory completion of prescribed training and performance of military duties;
- (26) the following limitations of movement:
 - (a) *Hip*: flexion less than 90°; extension less than 10° (from 0°);
 - (b) *Knee*: complete extension impossible; flexion less than 90°;
 - (c) *Ankle*: dorsiflexion less than 10°; plantar flexion less than 10°;
 - (d) *Toe*: stiffness which interferes with walking, marching, running or jumping.

3. *US Army and US Navy Regulations*

These are practically the same as those of the USAF.

4. *Belgian Regulations*

The various points developed in these regulations follow fairly closely those in the USAF regulations. They differ only in some minor details, such as those relating to the amputation of fingers, which is a cause for disqualification. In addition, they do not specify precise minimum limits, expressed in degrees, for movement of the joints which subjects must meet in order to be assessed as fit.

5. *Canadian, British and German Regulations*

These regulations stress the importance to be attached to the functional criterion when a candidate has to be rejected because of abnormalities or deformities of a limb or a part of a limb. They do not provide long lists of deformities or injuries, and are very sparing of explanatory comments.

In this respect they can be classed in the same group as the French regulations.

6. *Norwegian Regulations*

The regulations for Norway are exactly the same as those of the USAF.

(c) *Vertebral Column*

Functional soundness of the vertebral column is required in all the regulations. However, only the French and the German regulations specify, for the initial examination, a mandatory X-ray of the spine (cervical, dorsal, lumbar and sacral column): the negatives must be attached to the candidate's medical records. The X-ray examination must include antero-posterior lateral views.

On this particular point the regulations can be sub-divided into three categories, as follows:

1. *French Regulations*

Their main feature is that they have created a skeletal physical fitness standard as defined in Standard A and Standard B.

Standard A is required for fitness to use an ejection seat, while Standard B does not include fitness to use an ejection seat.

This classification is obviously based on the vertebral pathology attributed to the use of the ejection seat.

The category allotted to the candidate is expressed in the "aviation" profile through juxtaposing to the coefficient of the standard of general fitness "aviation" (SGA), the letter A or B corresponding to the category.

Examples: $\frac{SGA}{1A}$, $\frac{SGA}{1B}$, $\frac{SGA}{2A}$, $\frac{SGA}{2B}$.

SGA/0 means: unfit for flying duties. The coefficient 1 or 2 of the SGA corresponds to the various functions carried out by flying personnel.

Annex 1 presents the standards for admission and the standards to be used in periodic examinations for fitness to carry out the various functions of flying personnel.

The main features of the text of the French regulations on the subject and some explanatory notes contained in the technical notice on radiological examinations are presented here below:

"1. Major congenital or acquired spinal abnormalities and important disorders in posture must entail rejection.

The main major congenital or acquired spinal abnormalities are: evolutive arthrosis or arthritis and their sequelae, congenital blocks with major functional or dynamic disorders.

The major disorders in posture are particularly related to the following abnormalities:

1. important kyphosis and lordosis,
2. scoliosis with an angle close to 24°, if the subject has weak musculature,
3. some lumbo-sacral transitional abnormalities such as
 - total dislodgment of the "pivot-vertebra" from its bed, when the first "free" vertebra (sus transitional l vertebra) is completely located above the line drawn between the two pelvic crests.
 - association of a lumbar scoliosis of more than 15° and of the dislodgement — even a moderate one — of the "pivot vertebra".
 - very asymmetric transitional abnormalities (e.g. important oblique position of the sacral plate or vertebra presenting a frontal trapezoidal form).

2. Scoliosis

The term "scoliosis", as used here below, means a "true scoliosis", with a rotation of the vertebral bodies, and not the scoliotic posture.

The measurement of the scoliotic angle is carried out, according to the technique of Lippman and Cobb. On the antero-posterior X-ray plate, the line of the upper plate of the upper neutral vertebra and the line of the lower plate of the lower neutral vertebra are prolonged. The angle created by drawing two perpendiculars to these lines is the scoliotic angle.

The scoliosis is assessed according to its degree and the following indicative rules (see Annex 1).

- up to 15° (included): SGA/1A, if the subject has a good musculature;
- from 16° to 24° (included): SGA/1B;
- more than 24°: SGA/0.

Spondylolysis (isthmic lysis) without spondylolisthesis: SGA/1A;

Spondylolisthesis up to the 1st degree: SGA/1A;

Beyond this degree: SGA/0.

Note: The first degree of spondylolisthesis or retrolisthesis is a slipping of the vertebra above equal to or less than a quarter of the antero-posterior diameter of the underlying vertebral plate (practically, this corresponds approximately to a minimum slipping of 1 cm).

3. *Epiphysosis*, except when important disorders in posture or major morphological modifications of more than two vertebral bodies are present, is compatible with Standard SGA/1A.

The terms "important disorders in posture" and "major morphological modifications" are related to cuneiform deformities or flattening of more than two vertebrae, associated with important irregularities of vertebral plates, with or without dorsal kyphosis or with discal angularity.

On the other hand, moderate undulations or irregularities of the plates, limited to one spinal segment (cervical, dorsal or lumbar), and isolated notches of schmorl (intra-spongious hernias) are acceptable and compatible with fitness for flying duties in aircraft equipped with ejection seats.

4. Various minor abnormalities

Simple imbalance of the pelvis does not constitute in itself a cause for rejection. Some *minor* abnormalities, such as anterior retromarginal hernias, free anterior wedges, anterior wedge-shaped vertebrae without traumatic signs (the difference in height between the anterior and the posterior edges is less than 1 cm) are acceptable and compatible with fitness for flying in aircraft equipped with ejection seats.

5. Fitness of helicopter pilots

The standard of fitness required for helicopter pilots is the Standard SGA/1B, with regard to the spine (see Annex 1)."

2. American, Norwegian and Belgian Regulations

These regulations do not introduce any particular standard applicable to the type of flying duty performed or the type of aircraft flown.

The list of causes for rejection is therefore free from the various types of peculiarities found in the French regulations. It does, however, contain a wide range of details and thus covers most of the cases of vertebral pathology and of spinal posture. Such a wealth of detail makes these regulations distinctly more rigorous than those for the French Air Force. For purposes of illustration and comparison the text of the USAF regulations is quoted below. The other regulations in this category are, as has been said, practically similar:

- (1) history of disease or injury of the spine or sacroiliac joints, with or without objective signs, which has prevented the candidate from successfully following a physically active vocation;
- (2) arthritis of the spine (all types);
- (3) granulomatous disease of the spine, active or healed;
- (4) lateral deviation of the spine (scoliosis) of more than 2.5 cm from the normal midline;
- (5) abnormal curvature of the spine, of any degree, in which there is a noticeable deformity when the subject is dressed, in which pain or interference with function is present, or which is progressive;
- (6) spondylolisthesis; spondylolysis, if symptomatic;
- (7) herniated nucleus pulposus, or history of surgery for that condition;
- (8) healed fractures or dislocations of the vertebrae. A compression fracture, involving less than 25% of a single vertebra, is not disqualifying if the injury occurred more than one year prior to the medical examination and the subject is asymptomatic. A history of fractures of transverse processes is not disqualifying if the subject is asymptomatic;
- (9) spina bifida, when more than one vertebra is involved or if there is dimpling of the overlying skin;
- (10) juvenile epiphysitis with any degree of residual change as shown by X-ray or kyphosis;
- (11) fixed elevation and rotation of the scapula (Spengel deformity) which materially interferes with shoulder girdle function;

- (12) congenital or spastic torticollis which interferes with normal neck function;
- (13) cervical rib with demonstrable neurological or circulatory deficit;
- (14) osteomyelitis of vertebra, rib, sternum, clavicle or scapula;
- (15) deficient muscular development.

3. *British, Canadian and German Regulations*

The British and Canadian regulations confine themselves to very broad statements of a general nature. Details of the kind supplied in the regulations of the other two categories are completely absent.

Any effects on function which would prejudice flight safety are quoted as the *main criterion* on which an assessment of abnormalities should be based.

Although very far removed from the regulations in the second category from the point of view of the abundance of details supplied in the latter, the German regulations are in fact the closest approximation to them. On the other hand, they relax the standards for the rejection of personnel by allowing a certain amount of flexibility in particular cases, thus making the standards less hard and fast, and introducing a certain lack of precision in the examination conducted. Unlike those for France, the German regulations do not lay down separate standards according to the type of flying duty performed. They therefore appear to occupy a position which is out of line both with the French regulations and with those for America, Belgium and Norway.

The following are causes for the rejection of candidates for training as pilots of aircraft or helicopters:

- (1) abnormal curvature of the spine, scoliosis and growth disorders which are symptomatic or restrict movement;
- (2) degenerative changes, such as osteochondrosis, spondylosis deformans, spondylarthrosis, herniation of intervertebral disc, even after corrective surgery;
- (3) any deformity of the spine associated with neurological symptoms;
- (4) acute or chronic spondylitis (e.g. Bechterew's disease);
- (5) vertebral tumours;
- (6) deficiencies, noticeable deformities or sequelae of injury to the thoracic region or the shoulder girdle, resulting in a reduction of functional capacity.

In relation to the overall assessment of the subject's fitness, the following abnormalities may, at the discretion of the medical examiner, be compatible with the acceptance of candidates for training as pilots:

- (1) mild to moderately severe cases of Scheuermann's disease;
- (2) spondylolisthesis, unless any of the following are present:
 - (a) sacralgia or sciatica;
 - (b) vertebral slipping of more than 20%;
 - (c) symptoms of vertebral arch or articular dysplasia;
 - (d) marked trapezoidal deformity of the fifth lumbar vertebra, in which the sacral face has become more irregular.

In cases of anomalies of the transitional lumbosacral region, an abnormal articular condition associated with scoliosis of the lumbar spine constitutes an increased predisposition to the development of pathological alterations and the candidate must be rejected.

Fractures of the spinal column are assessed according to the degree of deformity and the functional and neurological findings.

B. PERIODIC EXAMINATIONS

The general principles and requirements for the upper and lower limbs applicable to candidates for flying duties also apply to trained personnel at their periodic examinations.

The *French regulations* give a general instruction which, although absent from the text of the other regulations, is certainly applied in practice, since it meets the spirit of their respective texts:

"Sequelae of injuries of fractures, or of osteoarticular or musculo-tendinous diseases, which do not interfere with function to a degree likely to compromise flight safety, in whatever circumstances, may be acceptable. (The opinion of the Unit Commanding Officer may, if necessary, be sought in regard to the possible effects, during flying, of the injuries noted.)"

The standards relating to the vertebral column are identical in their broad outlines to those for candidate aircrew.

Standard A in the French regulations applies to fighter, reconnaissance or bomber pilots.

Standard B applies to pilots of transport aircraft, bombers (propeller driven), twin-engined communications aircraft, liaison aircraft, single-engined light support aircraft, military reserve pilots, ab initio flying training instructor pilots, members of the flying personnel performing duties other than those of a pilot and to members of the flying personnel of the light aviation of the Army and of the Gendarmerie.

Helicopter pilots must also meet the requirements of Standard B.

The French regulations also state that an X-ray examination is performed only on request, when there is a clinical abnormality or because of a previous vertebral injury, particularly after an ejection, or in case of change of function in the flying personnel. Certain congenital abnormalities revealed on this occasion may be compatible with a decision of fitness for flying duties. Fractures such as "simple compression of the vertebral body" without injury to the posterior wall remain compatible with fitness for flying duties.

It will also be noted that the German regulations allow a wider measure of discretionary powers to the examiners than that already provided for in the case of candidates for flying duties (see above).

C. CONCLUSIONS

Although wide agreement exists on matters of principle, a great number of differences have been noted in regard to an assessment of the sequelae of disease or injury.

Some of the regulations agree that a certain degree of flexibility may be allowed for candidates for flying duties and for fully trained aircrew. Such flexibility is not, however, expressed in very precise terms and refers in a general and very vague manner to standards consistent with the same handling of an aircraft.

The solution adopted in the French regulations represents a realistic attempt, and one which should be highlighted, to find practical answers and to formulate them in the form of official instructions which are clear and unambiguous. It is only by considering the various kinds of flying duties with their specific pathology and their specific requirements that it is possible, in the presence of well defined defects or abnormalities, to arrive at standards which are compatible with the satisfactory performance of flying duties, and with due regard to flight safety.

Furthermore, osteoarticular traumatology is assuming such an important place in aviation medicine that very detailed texts seem much more desirable than texts which are too concise and reduced to a few general statements without explanatory comments.

It would therefore seem valuable to re-examine the threshold limits at which many sequelae of traumas, diseases or malformations of the limbs and of the vertebral column become compatible with flying. Such re-examination should compare first of all the precise requirements of the various types of flying duties and aircraft, and then the adaptability of the airman and the particular pathology to which he is exposed in each of the duties which he may be called upon to undertake.

A combination of the concepts underlying the drafting of the American regulations and of those on which the French and the West German regulations were based would probably help to find the ideal presentation or at least provide a text which is comprehensive and closer to the actual operational conditions of a modern Air Force and to the actual adaptability potential of the human factor.

CHAPTER III

LUNGS, PLEURAE AND THORACIC CAGE

A. EXAMINATION METHODS

The methods of examining the respiratory organs and the respiratory function have numerous points of similarity in the various regulations.

A radiophotographic examination of the chest (or an X-ray or a radiosopic examination) is a mandatory requirement at the selection examination and at each subsequent periodic examination. This requirement is found in all the official texts (Manuals or Regulations) relating to the medical fitness examination.

Under the German regulations a spirometric test to assess the vital capacity, and a Tiffeneau test are also required during the initial selection examination and during the periodic examinations. In addition, when justified, and particularly if emphysema is present, exhaustive tests of the pulmonary function are carried out.

Furthermore, the French regulations require such tests to be performed for an asthmatic condition, in addition to the acetylcholine test.

In actual fact, an examination of the respiratory function using spirographic methods is carried out at all the aircrew medical examination centres either on a routine basis during the examination for the selection of aircrew, or during the examination of trained aircrew members who contract a respiratory disease during their service, or, in certain doubtful cases of applicants, during the selection examination. As and when necessary, the examination of the ventilatory function is supplemented by a measurement of the arterial gases and an examination of the diffusion capacity, most frequently when it is a question of determining whether an aircrew member can be re-accepted after recovering from his illness.

The various texts contain numerous references requiring the use of tests exploring the respiratory function before a final decision can be reached. A description of the methods of examining the respiratory organs and the respiratory function, used by the various NATO Air Forces for the medical selection and periodic checks on aircrew members, can be found in AGARDograph No.196, by Dr A.Scano¹, published by AGARD.

B. FITNESS STANDARDS

(a) Examination for the Initial Selection of Applicants for Aircrew Duties

All the regulations require:

1. clinical and radiological integrity of the respiratory system;
2. functional integrity of the thoracic cage.

Particular consideration should be given to a number of points.

(1) *History of pulmonary tuberculosis*

Applicants who have a *history* of active pulmonary tuberculosis are assessed as unfit.

In seven regulations, this rule may be waived if the applicant can prove the clinical and radiological inactivity of the disease for at least 5 years (USAF, US Navy, Canada, Norway), for at least 4 years (RAF), for at least 2 years (US Army), and for at least 3 years (Federal Republic of Germany, and in the absence of effective limitation of the respiratory function).

Such details about the period of inactivity are absent from the Belgian and French regulations. The latter do, however, stipulate that cases of primary infection receiving prophylactic treatment should be declared unfit until the treatment has been completed. Primary infection sequelae which appear as calcified nodules without any clinical or biological substratum are compatible with fitness.

¹ A.Scano — *Survey of Current Cardiovascular and Respiratory Examination Methods in Medical Selection and Control of Aircrew*. AGARDograph No.196, AGARD, Paris, December 1974.

(2) *Active pulmonary tuberculosis*

All forms of active pulmonary tuberculosis are grounds for disqualification.

(3) *History of pleurisy – Sequelae of pleurisy*

The precautions to be taken in these cases are formulated with varying degrees of strictness, but it can be said that all the regulations require a minimum period of two or three years to elapse between termination of the illness and the date at which a decision is taken.

(a) *History of pleurisy*

In the *Canadian* regulations a past history of pleurisy with an effusion during the preceding 5 years justifies disqualification.

The *French* regulations assume that sequelae of tuberculous serofibrinous pleurisy without any clinical or biological substratum are compatible with fitness. The previous regulations required that healing occurred more than *three* years prior to the date of application. The present regulations do not require this condition.

The regulations for the *American Armed Forces* reduce the minimum period to *two* years. In fact:

– the USAF regulations require that an applicant be assessed as unfit in case of tuberculous pleurisy or pleurisy of unknown aetiology with a positive tuberculin test or proof of the conversion of the tuberculin test, unless the pleurisy has been treated by anti-tuberculous therapy for at least one year, and has then remained quiescent for at least *two* years. As in the Canadian regulations, a past history of pleurisy with an effusion which has occurred during the preceding 5 years and is of unknown aetiology justifies disqualification, unless the Mantoux test is negative on at least two occasions.

– the US Army and the US Navy regulations reject applicants who have had pleurisy with an effusion of unknown origin during the preceding *two* years.

Exactly the same provisions appear in the *RAF* regulations, which consider that a past history of pleurisy with an effusion, suspected to be tuberculous in nature, should be a cause for declaring the applicant *temporarily* unfit, if the illness occurred less than *two* years previously.

The *Belgian* regulations, too, stipulate that a past history of pleurisy dating back to less than 2 years is sufficient reason for declaring an applicant unfit.

In the *German* regulations, a history of exudative pleurisy with reduction of the pulmonary function is a cause of unfitness. There is no provision concerning a period of temporary unfitness.

(b) *Sequelae of pleurisy*

Pleural adhesions, except for minimal blunting of the costo-phrenic angles, signify the unfitness of the applicant, in the USAF regulations.

Under the US Army and the US Navy regulations, applicants who have chronic fibrous pleurisy of *non-tuberculous* origin are not accepted whenever it has spread sufficiently to interfere with the pulmonary function or to obscure the pulmonary field in the roentgenogram. The text of the Belgian regulations is practically exactly the same as that of the US Army; it states that pleural sequelae less than two years old, and older sequelae which, because of their location and their extent, may interfere with pulmonary ventilation or the safe performance of flying duties, are reasons for declaring an applicant unfit.

Under the RAF regulations and those for the German Armed Forces, interlobar adhesions resulting from exudative pleurisy which is clinically cured constitute grounds for unfitness.

(4) *Spontaneous pneumothorax*

The *French* regulations stipulate that a past history of spontaneous pneumothorax is a disqualifying factor.

Immediate disqualification is also provided for in the USAF, US Army, Federal German Republic, Canadian and Norwegian regulations.

The US Navy regulations are more explicit: a history of *recurrent* pneumothorax is a reason for disqualification, but it is also stated that pneumothorax, or a history of pneumothorax, if due to simple trauma or a surgical operation, justifies rejection if the pneumothorax occurred less than one year previously.

In the case of spontaneous pneumothorax, the applicant is declared unfit if this has occurred less than three years previously. Surgical treatment is compatible with fitness if there is no sequela and if the pulmonary function tests are normal.

The Belgian regulations make no specific reference to spontaneous pneumothorax in a list of diseases of the respiratory organs entailing the non-acceptance of applicants. However, according to the context, there is no doubt that a past history of spontaneous pneumothorax signifies immediately the non-acceptance of applicants.

Only the RAF regulations provide a less strict note. Applicants who state that they have a past history of spontaneous pneumothorax have to be referred to the Consultant in Chest Diseases for opinion, and acceptance

for flying or ground duties will depend on the type of treatment given, on the frequency of the occurrence of pneumothorax and on the length of time since the last occurrence.

However, another Article in the regulations, referring to the opinion to be given by the Consultant in Chest Diseases, throws light on this text and leaves no doubt whatever on the decision to declare an applicant unfit in such cases: any undeniable evidence of disease of the lungs, the mediastinum or the pleurae constitutes *definite* incompatibility with the performance of flying duties and *probable* incompatibility with ground duties, though the opinion of the Consultant in Chest Diseases must be obtained by the Central Medical Board in all doubtful cases.

Thus, if the opinion of the Consultant is required when there is a past history of spontaneous pneumothorax, this is obviously to supplement the medical examination file by having the views of the specialist. If the past history of pneumothorax is established, the decision to reject an applicant will, in the end, be unavoidable, if the pneumothorax is of recent date.

(5) *Asthma and asthmatic conditions*

Asthma, verified asthmatic conditions, pulmonary emphysema – bullous or generalised – are grounds for disqualification in all the regulations.

For hay-fever, see further on (otorhinolaryngological disorders, Chapter XVII).

The French regulations require a test of maximal expiratory speed and vital capacity tests, as well as the acetylcholine test, in order to assess any asthmatic syndrome.

The official comments on the Belgian regulations also contain similar requirements.

The American provisions in regard to methods of examination impose pulmonary function tests.

A history of asthma is also a disqualifying factor in all the regulations. The American regulations provide, however, an important factor in regard to a past history of *infantile* asthma: such history is compatible with acceptance as an aircrew member, if there is a trustworthy history that the subject has been completely free from symptoms since the twelfth birthday.

(6) *Bronchiectasis*

Bronchiectasis is a cause for rejection in all the regulations. However, the American regulations allow the acceptance of an applicant if this condition has been cured as a result of surgical treatment. Such a cure naturally implies normal pulmonary function.

(7) *Chronic bronchitis*

Chronic bronchitis is obviously incompatible with fitness. The three American regulations add the following when referring to this criterion: "with evidence of disturbance of pulmonary function".

These details assist the examining medical officer to take appropriate action when confronted with a history of attacks of bronchitis during childhood. His decision will be determined by the presence of sequelae at the time of the examination and the degree to which they affect the pulmonary function.

This matches the cautious text of the RAF regulations in this respect. "Frequent attacks of bronchitis during childhood are often suggestive of infantile asthma and require careful assessment; a candidate must not be accepted for flying duties unless he has been free from all bronchial infections since puberty and clinical examination of the chest is entirely clear. A history of a single mild attack of bronchitis is not significant."

(8) *Other diseases*

All the regulations require clinical and radiological integrity of the respiratory apparatus and the functional integrity of the thoracic cage.

Details in regard to these general statements vary.

In regard to respiratory pathology, they are restricted, in the Belgian, French, West German and Canadian regulations, to the most frequently encountered cases or cases which are the most difficult to assess during the fitness examination.

The three American sets of regulations and the Norwegian regulations on the other hand give a very comprehensive list of the pathological conditions which determine unfitness because of the effect on the clinical, radiological or functional integrity of the thoracic organs. In this long list it is important to give particular prominence to the details concerning a *history of chest and lung surgery*.

The following are causes for rejection:

- (a) a history of lobectomy or multiple segmental resections, if this has considerably reduced vital capacity,

timed vital capacity or the maximum breathing capacity, or if a pulmonary pathology still exists. The removal of more than one lobe is a ground for unfitness, even in the absence of any pulmonary pathological element:

(b) a history of intrathoracic surgery, until complete recovery, as indicated by the *return to normality* of the pulmonary function and the absence of any residual clinical symptom.

(c) a history of tracheotomy. The *Belgian* regulations are very precise in this connection. Any tracheotomy for a tumour, tuberculosis, syphilis or Quincke's oedema, constitutes grounds for the rejection of an applicant. Subjects who have undergone tracheotomy for any other reason may be accepted, provided that the scar is more than *one year* old and that there is no consequent functional disorder. The US Army regulations are similar to the *Belgian* requirements. They are, however, less strict in regard to the period following the operation, if a tracheotomy was performed for a reason which is compatible with acceptance: a three-month period is sufficient.

The other regulations are silent on this particular point; there is no doubt however that they adopt the same attitude by leaving the examiner free to decide the minimum period between the medical examination and the tracheotomy.

(b) Periodic Examination of Aircrew

Generally speaking, the requirements are the same as for the initial selection examination, except in regard to the following points:

1. Pulmonary Tuberculosis

The requirements in regard to serving aircrew, after treatment for pulmonary tuberculosis or pleurisy of a tuberculous aetiology, are fairly similar in the various regulations.

(1) Belgian regulations

A decision to declare an individual fit for flying is authorised whenever the lesion can be considered as healed. The return to flying duties should, however, be *gradual*. Permission to fly will be given only when the absence of any symptomatology has been well established, and provided a comparison of the X-ray photographs made at intervals of at least six months can confirm the absence of any activity.

During the first *two* years, the aircrew member is prohibited from flying in tropical climates. If, at the end of the *two*-year period of observation, the radiological and clinical examinations confirm that the lesions have healed, this latter restriction can be lifted.

(2) RAF regulations

These are very similar to the *Belgian* regulations. An aircrew member who contracts pulmonary tuberculosis during his period of service is assessed as unfit for as long as the disease remains active. After being declared completely recovered because of the continued inactivity of the disease, he is not allowed to return to flying duties until three months after discharge from hospital. In such a case, his fitness for flying comes within a category which includes limitations. *Two* years after he leaves hospital, he may again be declared fit for full flying duties, but for service solely in the United Kingdom and Western Europe.

(3) USAF regulations

Any pulmonary tuberculosis, irrespective of its degree or type, including tuberculous pleurisy, constitutes grounds for unfitness, unless the disease has remained inactive for at least *18* months after the end of an appropriate period of active therapy.

Surgical treatment of tuberculosis disqualifies any aircrew member for a period of *two* years after the operation.

(4) US Army regulations

Any type of pulmonary tuberculosis constitutes grounds for unfitness during the period of therapy by medication or for as long as the pulmonary function has not reached a sufficiently satisfactory level. The latter is assessed by evaluating the vital capacity, which must be at least 80% of the normally predicted value.

In cases of tuberculous pleurisy with an effusion, the resumption of flying duties cannot be authorised, after termination of the disease, until *12 months* after therapy has stopped.

(5) US Navy regulations

Any form of tuberculosis constitutes unfitness, unless a mild form of tuberculosis has remained inactive for at least *24* months after cessation of chemotherapy involving the use of at least two anti-tuberculosis substances, or treatment which combines chemotherapy with surgery. The latter must have taken place at least one year before the treatment was stopped, and anti-tuberculosis chemotherapy using two anti-tuberculosis drugs must have been carried out for at least *24 months*.

(6) *French regulations*

After a tuberculous disease has been cured, resumption of flying duties can be envisaged only after the cessation of treatment and after an examination in a specialised department. If the treatment included a limited exeresis, a decision of fitness can also be granted after an examination in a specialised department.

(7) *Canadian Air Force regulations*

Patients leaving hospital are kept under observation by the latter until the end of the period of chemotherapy. Temporary restrictions on flying are the responsibility of the Medical Board.

(8) *Regulations of the Federal Republic of Germany*

The standards laid down for the initial examination also apply to class II and class III (periodic examinations for pilots and all other members of flying personnel): unfitness. They can be relaxed if there is only a slight and acceptable limitation of the pulmonary function.

2. *Spontaneous Pneumothorax*(1) *Belgian regulations*

No particular reference to pneumothorax is made in the case of the periodic examinations. It can be inferred from this that this condition constitutes unfitness, at least of a temporary nature, and that complete fitness can be envisaged only if the respiratory function has returned to normal.

(2) *French regulations*

Any past history of spontaneous pneumothorax requires hospitalisation of the aircrew member in a specialised medical department before any decision can be made about the resumption of flying duties. As mentioned in connection with the Belgian regulations, this statement means that permission to resume flying duties is subject to evidence of a normal pulmonary function.

(3) *USAF regulations*

Cases of spontaneous pneumothorax are assessed as unfit. If there has been an isolated and single episode, a waiving of the regulations and an assessment of fitness for flying duties can be considered if the examination shows complete recovery with full expansion of the lung, normality of the pulmonary function as demonstrated by appropriate tests and the absence of any pathology which might predispose to a recurrence.

If these conditions are not met, a return to flying duties can be envisaged only after surgical correction, successful pleurodesis and demonstration of normal pulmonary function after an observation period of 6 months (all such cases require a low-pressure chamber test in the presence of a medical officer).

(4) *US Army regulations*

The requirements are similar to those of the USAF, but the period of observation is reduced to 3 months.

(5) *US Navy regulations*

As mentioned when referring to the selection examination, a spontaneous pneumothorax constitutes unfitness for flying duties. The requirements are exactly the same as for the initial selection examination.

A surgical operation is acceptable for a return to flying duties, if there are no sequelae and the pulmonary function tests prove normal.

In practice, the US Navy regulations can, in fact, be regarded as similar to those of the USAF and the US Army but the duration of the observation period is not fixed.

(6) *RAF regulations*

Trained aircrew personnel who experience a spontaneous pneumothorax can be considered fit for flying duties only after pleurodesis.

(7) *Canadian Air Force regulations*

A spontaneous pneumothorax in trained aircrew constitutes unfitness for flying duties. However, after surgical treatment, a re-assessment of fitness for full flying duties can be considered three months after the operation if there is complete recovery of the function.

(8) *Regulations of the Federal Republic of Germany*

A spontaneous pneumothorax constitutes unfitness for flying duties. Account should, however, be taken of the flexibility allowed in the case of trained aircrew if treatment has been effective and function recovery is satisfactory (see above under 1. Pulmonary tuberculosis).

3. *Bronchiectasis*

Under the USAF regulations, a declaration of fitness for flying duties can be made again after surgical treatment of bronchiectasis provided recovery is complete, pulmonary function is normal and the subject has successfully completed a test in a low-pressure chamber.

Although the texts of the other regulations are silent or less explicit in this particular instance, it can nevertheless be assumed that the terms of the USAF regulations are also being applied — in practice — in the other Air Forces, since recovery of a normal pulmonary function is always a *sine qua non* condition for a return of duty following serious impairment of the respiratory function or after a lung or chest operation.

C. CONCLUSIONS

The regulations produced by the various countries indicate that the basic concepts underlying the requirements laid down are similar or very close. It is only in such details as the figures quoted for the period of unfitness after some diseases or after certain types of medical or surgical treatment that any differences are found. In such a field, however, the opposite would have been surprising.

These periods are, moreover, minimum periods and, as must always be the case, the final decision must be governed by the results of the functional tests.

The following are some conclusions which may help to improve the degree of harmonizing various clauses in the existing regulations.

(a) A radiophotograph of the lung or a radiographic negative should be mandatory at all initial selection examinations and all periodic examinations.

A radioscopic examination should no longer be regarded as sufficient. In such an important matter as a medical fitness examination, documents are essential, not only to determine the decision following the examination, but also to permit comparisons with previous conditions found at periodic examinations throughout an airman's career. There is no doubt that this particular point should be included in any standardization of military regulations, and general approval to this would no doubt be readily obtained.

(b) The lists, however long, of the pathological conditions indicating unfitness certainly offer advantages for the medical examiner, but they also have the inherent danger of being incomplete, either because certain rarely found conditions have been omitted, or because borderline situations could not be described with complete details of their varying characteristics. Therefore, it is useful to refer at the head of the Chapter on the respiratory function, as the French regulations do, to the positive basic "pillars" on which any decision in regard to fitness must rest, namely:

1. clinical and radiological soundness of the respiratory apparatus;
2. functional soundness of the thoracic cage.

It is after these statements that the lists of pathological conditions constituting the negative or disqualifying aspect of the fitness examination fall into their normal place.

To assess clinical and functional soundness there is really no need to list all the functional tests to be applied by the medical examiner. However, in view of a possible standardisation of the regulations, there is one point which should be stressed. The advisability of recommending it or specifying it as mandatory in all the regulations would probably need to be studied. This is the requirement, as found in the German regulations, that the initial examination of applicants and the periodic examinations for aircrew over 35 should include — at the very least — measurement of the vital capacity, a maximum breathing capacity test and a Tiffeneau test. This would make for clarity but would in no way prevent the examiner from exceeding this minimum if he considered it desirable or necessary.

(c) For the initial examination the minimum period of inactivity for a past history of pulmonary tuberculosis varies between two and five years. Precautionary measures in this very important matter tend to suggest recommending the longer period: five years.

In regard to pleurisy sequelae, the differences range from two to five years. For a past history of pleurisy with an effusion, a period of five years should be made a general rule. For the sequelae of dry pleurisy or pleurisy of unknown aetiology, a period of two years would be generally accepted, since this is the period most often quoted. The above is valid only if there is no interference with the pulmonary function.

With regard to pleural adhesions it would be helpful to state, as in the USAF regulations, that a minimal blunting of the costo-phrenic angles is not sufficient ground for unfitness. Such a statement would have the advantage of unifying the decisions taken on conditions which are fairly frequently encountered in applicants. It would also be useful to state that interlobar adhesions constitute grounds for unfitness.

On the question of *spontaneous pneumothorax* the majority view is that it should constitute grounds for permanent unfitness. It would seem that in this particular area some of the regulations should omit an unnecessary list of very rare conditions which raise hopes in the applicant — most often illusory ones — of being passed fit at some future date. Concise, clear and unambiguous wording of the text should settle the matter by eliminating straightaway any applicants who have a past history of pneumothorax at the time of the initial entry examination.

Asthma and *asthmatic conditions* are disqualifying in all the regulations. The latter, as is proper, require functional tests to establish or confirm the diagnosis. However, the precise details given in the American regulations about a history of *infantile asthma* are valuable and deserve to be studied by the AGARD Medical Panel with a view to formulating a text acceptable to all concerned: a history of infantile asthma is compatible with acceptance as an aircrew member if there is trustworthy evidence to prove that the subject has been free from symptoms since the twelfth birthday.

A history of *bronchitis* often gives rise to some doubt in the mind of the examiner during a medical examination. One can therefore only but approve the preciseness of the three sets of American regulations when they amplify the concept of a history of bronchitis by adding the words "with evidence of disturbance of the pulmonary function". This additional phrase reflects the character of the explanatory comments in the various regulations, emphasizing the degree of impairment of the pulmonary function as the criterion on which the examiner must base his decision when confronted with a history of bronchitis going back to childhood or to adolescence.

With regard to a *lobectomy*, the removal of more than one lobe must always be a cause for definite rejection. In all other cases, the decisive factor will be the results of functional tests. The same applies to a history of intrathoracic surgery. The development of *intrathoracic methods of surgery* is an argument in favour of the inclusion, in all the regulations, of a clear statement indicating the threshold values beyond which, in the results of the conventional functional tests, an applicant must always be rejected.

(d) *Periodic examinations*: Here again the concepts of the duration of the period of observation after termination of treatment should be considered, because of their present variability.

1. *Pulmonary Tuberculosis*

The observation period following confirmation of the inactivity of the lesions by radiological and clinical examinations varies from 12 to 36 months, according to the regulations concerned, but the period of 24 months quoted in several of them could be used as a basis for a standard minimum period, still implying temporary unfitness, whether after chemotherapy or after surgery.

2. *Pneumothorax*

The text of the USAF regulations gives the sum total of all the requirements to be met for again passing as fit any subject who had exhibited this condition. Its statement is the most complete, while remaining very concise.

Reference should be made to paragraph (3) above, under the heading "Spontaneous pneumothorax", for details relating to the periodic examination. This should become a general rule as a written basis for the principles to be applied in practice in all the Air Forces.

3. *Bronchiectasis*

The USAF requirements should be highlighted in regard to a point which does not appear in any of the other regulations. The examination of the pulmonary function after a surgical operation, with a view to assessing its normality, includes a test in a low-pressure chamber.

CHAPTER IV

CARDIOVASCULAR SYSTEM

GENERAL PRINCIPLES

- i. All the regulations require the circulatory system to be sound, as verified by clinical, radiological and electrocardiographic examination.
- ii. An electrocardiographic trace in all the peripheral and precordial derivations is required both for the initial examination and at each subsequent periodic examination.

Only the Canadian regulations are less exacting: an electrocardiogram is required:

- (a) on enrolment;
- (aa) every four years up to the age of 35;
- (aaa) every year after the age of 35.

- iii. Teleradiography of the heart is required if there is any appreciable enlargement of the cardiac area, as revealed by a clinical or X-ray examination.

The American, Canadian and Belgian regulations state that subjects whose transverse cardiac diameter exceeds the normal value by more than 15% must be disqualified.

- iv. Aircrew applicants and aircrew in service undergo special examinations and exercise tests to enable the cardiac functional responses to be assessed.

Under the French regulations, these responses must be distinctly satisfactory and compatible with *prolonged* physical exertion, even at altitude. Under the Belgian regulations they must be such as to enable subjects to withstand, without difficulty, any exacting conditions resulting from flying.

The German regulations require these responses to show that the heart is capable of withstanding high stress loads.

For this purpose a few tests are laid down in all the regulations, but the latter rarely indicate the interpretation to be placed on the results of such tests in order to arrive at a decision in regard to fitness or unfitness for flying duties.

In actual fact, the techniques of the tests and the interpretation of the results are most frequently dealt with in special instructions. A description of the various tests currently used by the Medical Services of the NATO Air Forces to assess the cardiovascular function in applicants for aircrew duties or in serving aircrew members has been given in AGARDograph No.196, already quoted above, and published in December 1974 under the direction of Dr A.Scano¹, to which reference should be made.

- v. All the regulations give a more or less detailed list of the diseases constituting grounds for disqualification: the presence of such diseases means that the circulatory system no longer meets the basic requirement that the system should be organically and functionally sound.

Such a list provides an opportunity of indicating any authorised departures from the regulations or the precautions to be taken because of the existence of a past history of such diseases.

A. SELECTION EXAMINATION OF APPLICANTS

(a) Factors on which an Assessment of the Cardiovascular Function is Based

The elements used in assessing the *cardiovascular function* and referred to in all the regulations are the following:

1. pulse rate;
2. blood pressure;
3. electrocardiogram;
4. cardiac tolerance to physical exertion, although the regulations are much less precise on this point.

¹ A.Scano - *Survey of Current Cardiovascular and Respiratory Examination Methods in Medical Selection and Control of Aircrew*. AGARDograph No.196, AGARD, December 1974.

1. *Pulse Rate*(1) *Belgian regulations*

In the lying position, the pulse rate must not in principle be more than 84 beats a minute.

Immediately on assuming a vertical position, the pulse rate must not exceed 108 beats a minute. A stabilised pulse rate must not exceed 96 beats.

Any abnormalities are assessed in relation to the clinical examination. Orthostatic tachycardia, and any disturbances of the rhythm which are of pathological significance, are grounds for rejection.

(2) *French regulations*

Disturbances of the cardiac rhythm are disqualifying factors. However, certain types of *neurotonic* tachycardia not exceeding 100 beats per minute (subject seated) and which react favourably to the exercise and hypoxia tests, sinus bradycardia not associated with any subjective disorders and reacting favourably to the exercise and hypoxia tests, and sinus arrhythmia are frequently compatible with flying and need not signify disqualification.

Borderline cases require a period of observation in a specialized medical department before a decision to accept them can be taken.

(3) *German regulations*

The following are grounds for rejection in the case of applicants for training as pilots:

(a) *bradycardia* of 60 beats or less a minute, when a clinical examination or an electrocardiogram shows that this is due to an organic heart disease.

(b) *tachycardia* reaching or exceeding 100 beats a minute when checked a number of times with the subject in the lying position and when the cardiologic examination demonstrates the existence of an organic heart disease.

(c) *paroxysmal tachycardia*, or paroxysmal atrial flutter or fibrillation.

(4) *RAF regulations*

These distinguish between the sitting pulse, and the standing pulse, and the pulse taken during and after exercise.

(a) *bradycardia*: the regulations merely refer to the fact that rates of 48 beats per minute and below may occasionally be found in very athletic persons who go in for strenuous sports.

(b) *tachycardia*: it is *never* advisable to accept a candidate whose sitting pulse rate is persistently more than 100 beats per minute. It is *rarely* advisable to accept a candidate with a sitting pulse rate which is persistently over 90 after due care has been taken to allow the pulse to settle and to eliminate the emotional element, the subject's temperature being normal.

When persistent tachycardia is the only abnormal element in the medical examination, the applicant is assessed as temporarily unfit and then re-examined after an appropriate interval. The standing pulse rate should not exceed the sitting rate by more than 24 beats per minute.

(c) the *exercise test* consists of a *step-test lasting one minute* and comprising 20 climbing movements on to a chair 15 inches high. The subject raises himself on to the chair by placing one foot on the chair and then the other foot. He gets down from the chair in the same manner, lowering first one foot and then the other. The pulse rate immediately after the test should not exceed the sitting pulse rate, taken before the test, by more than 36 beats per minute. One minute after completion of the test, the pulse rate should have returned to normal.

(5) *USAF, US Army, US Navy and Norwegian regulations*

(a) *bradycardia*: the references to this do not include a threshold rate below which the applicant would have to be rejected. He is declared unfit whenever any pathological conditions related to fainting are observed.

(b) *tachycardia* constitutes grounds for rejection of the USAF applicant if the resting pulse rate exceeds 100 beats per minute, unless the examiner can establish that such tachycardia is a psychic reaction and is not caused by a pathological condition.

In the US Navy and the US Army any persistent tachycardia marked by a resting pulse rate of at least 100 beats per minute is a disqualifying factor irrespective of the cause.

The Norwegian regulations are in line with those of the USAF.

(6) *Canadian regulations*

(a) *bradycardia* associated with a pathological condition constitutes grounds for disqualification. However,

bradycardia not due to any disease condition and associated with moderate enlargement of the cardiac area, such as is frequently found in an athlete who has undergone extensive training, is not a cause for rejection.

- (b) *tachycardia* of a pathological character is disqualifying, but references to it do not include a threshold pulse rate above which the applicant must be rejected.

2. *Blood Pressure*

The various regulations draw examiners' attention to the need for care in interpreting applicants' blood pressure.

In cases of doubt it should be measured on several occasions, if necessary, at intervals of a few days, since an emotional factor, which is a normal occurrence at the time of the examination, may temporarily affect the actual blood pressure values. Nevertheless, in spite of these reservations, all the regulations, except those of the RAF, have indicated threshold values for the acceptance of applicants. The levels for these threshold values are similar or very close in all the various regulations.

(1) *Belgium*

The systolic pressure, as determined by the auscultatory method, must not exceed 150 mm Hg at the initial examination (160 mm Hg at any other examination), nor be less than 100 mm Hg.

The diastolic pressure must be between 90 and 60 mm Hg.

When the pressure values exceed the upper limits quoted above, they generally constitute grounds for rejection if they persist after 30 minutes' rest in the recumbent position.

(2) *France*

The systolic pressure determined by means of a mercury sphygmomanometer should not be more than 150 mm Hg, if necessary after 30 minutes' rest, nor less than 110 mm Hg. During the examination of applicants presenting a tall and underweight body-build, who tend to be particularly sensitive to acceleration, orthostatic hypotension must always be systematically investigated.

The diastolic pressure must not be more than 90 mm Hg.

The differential pressure should be within the physiological margins.

(3) *Germany*

Hypertension is present when the systolic pressure in the lying position is more than 150 mm Hg and when the diastolic pressure exceeds 95 mm Hg. These values are the mean values of frequent measurements taken on subjects at rest.

Hypotension is present when the systolic pressure at rest is less than 100 mm Hg. When orthostatic hypotension is suspected, an appropriate test must be carried out. (Tilt-table test.)

(4) *United Kingdom*

Systolic pressures of 160 mm Hg in conjunction with tachycardia can be ignored, by reason of emotional factors, if there are no symptoms of cardiovascular or renal disease, if the body temperature is normal and if the diastolic pressure remains between 70 and 90 mm Hg.

Systolic pressures of 105 mm Hg or even lower are sometimes found in healthy individuals. However, the combination of a low normal systolic pressure with a low diastolic pressure is an indication of a liability to syncopal episodes.

A diastolic pressure of over 90 mm Hg in a candidate can be ignored if the remainder of the examination is satisfactory and if, in particular, renal function proves to be normal.

A diastolic pressure below 70 mm Hg, associated with low systolic pressure, is not in itself sufficient to warrant an assessment of unfitness, but calls for a great deal of caution.

Diastolic pressures below 60 mm Hg should be regarded, if they persist, as grounds for the rejection of candidates for flying duties, as they are rarely found in normally robust individuals.

(5) *United States of America*

In the USAF and the US Navy candidates are rejected on grounds of hypertension if the systolic pressure measured in the sitting position during repeated examinations gives mean values of 140 mm Hg or more, and if the diastolic pressure, in the same conditions, is more than 90 mm Hg.

Systolic pressures lower than 100 mm Hg are cause for rejection, unless no other symptoms of pathological nature are present.

However, the US Army regulations require rejection of candidates if the systolic pressure is below 90 mm Hg and if the diastolic pressure is below 60 mm Hg, or again, if the orthostatic tolerance test does not give satisfactory results.

(6) *Canada*

Candidates are rejected if they have a sustained blood pressure of more than 150/90 mm Hg, or less than 100/60 mm Hg, with a light build and a history of vertigo and syncope.

3. *Electrocardiogram*

(1) *The French regulations* give the following details on interpreting electrocardiographic abnormalities.

Isolated electrocardiographic abnormalities of repolarisation must be very carefully investigated in relation to the age of the candidate, his history, and results of functional tests.

First degree atrioventricular blocks with a PR interval of 24 hundredths of a second or more are grounds for rejection. On the other hand, a PR interval of between 21 and 24 hundredths of a second, particularly if observed in athletic subjects, may be compatible with fitness if it is reduced during exercise and if it is the only cardiac abnormality. The following may also be compatible with fitness:

- (a) incomplete and isolated right bundle branch blocks;
- (b) isolated and sporadic extrasystoles, which disappear after exercise.

The Wolff-Parkinson-White electrocardiographic syndrome is however cause for rejection.

(2) *The USAF regulations* present almost similar points of view.

The following electrocardiographic abnormalities indicating serious conduction defects are causes for rejection:

- (a) complete left bundle branch block;
- (b) complete right bundle branch block;
- (c) Wolff-Parkinson-White syndrome;
- (d) first degree atrioventricular block, unless the clinical examination reveals no other cardiac abnormality;
- (e) second and third degree atrioventricular block.

Major arrhythmias, such as atrial flutter or fibrillation, ventricular tachycardia or ventricular fibrillation or multifocal premature ventricular contractions are causes for rejection when revealed by electrocardiography or established on the basis of well-defined past history.

(3) *The US Army regulations* specify as causes for rejection:

- (a) the three degrees of atrioventricular block;
- (b) the Wolff-Parkinson-White syndrome;
- (c) left bundle branch block;
- (d) right bundle branch block, unless the heart examination shows no other cardiac disease and if the block is presumed to be congenital in origin;
- (e) persistent premature contractions;
- (f) syndromes with short PR interval, predisposing to paroxysmal arrhythmias;
- (g) electrocardiograms with borderline abnormalities, until reviewed by the Surgeon General.

(4) *The US Navy regulations* are similar to those of the USAF.

(5) *The Norwegian regulations* are also similar to those of the USAF.

(6) *The RAF regulations*, which require an electrocardiogram to be recorded for all candidates for flying duties, make no special comment on the electrocardiographic abnormalities which would be a cause for rejection.

(7) *The Canadian regulations*, which also specify the recording of an electrocardiogram at the selection examination, require the rejection of subjects who have persistent or recurrent arrhythmias, such as paroxysmal atrial tachycardia, atrial fibrillation, atrial flutter or atrioventricular block.

(8) Under the *German regulations* candidates whose electrocardiogram reveals the following are assessed as unfit:

- (a) atrial flutter;
- (b) atrial fibrillation;
- (c) multifocal extrasystoles;
- (d) first degree atrioventricular block;
- (e) second and third degree atrioventricular block, not disappearing during exercise;
- (f) Wolff-Parkinson-White syndrome and biphasic blocks;

- (g) complete left bundle branch block; left posterior hemi-block;
- (h) sequelae of infarction.

Any other electrocardiographic findings (e.g. mild excitability abnormalities, left anterior hemi-block, right bundle branch block, incomplete block) must be interpreted within the framework of the whole cardiological examination.

4. Exercise Tests

Some of the regulations make a physical exercise test *mandatory* for a general assessment of the circulatory function. Others specify its performance whenever certain facts in past medical history or certain findings as a result of the clinical examination point to doubts about the normality of the cardiac function.

(1) Belgium

The regulations require each candidate to undergo an *exercise test* at the initial selection examination in order to assess the extent of cardiovascular tolerance to prolonged and exhausting exercise. The type of test used is not mentioned. However, the Harvard step-test, of five minutes duration, has in fact been used since 1946 and subjects with an index of less than 70 are disqualified. This disqualifying index is reached whenever the total number of beats recorded for 30 seconds, at the start of the second minute after cessation of the exercise, and then at the start of the third minute and finally at the start of the fourth minute following the completion of the test, exceeds 220.

(2) France

The French regulations make it a *requirement* that at the initial examination the cardiac functional responses should be absolutely satisfactory and compatible with *prolonged* physical stress, even at altitude. In connection with subjects presenting a tall and underweight body-build, it is pointed out that because of possible intolerance to acceleration, orthostatic hypotension should be systematically investigated. The tests advocated or prescribed for this purpose are not mentioned.

In the same way, the regulations mention that isolated electrocardiographic abnormalities of repolarisation must be considered in terms of several factors, one of the most important being the results of *functional* tests. Some functional tests, usual in the past, have to-day fallen into disuse, e.g. hypoxia test in low pressure chamber at an altitude of 5000 m for 20 minutes, ergotamin tartrate test, potassic load test.

A technical notice gives some general lines on *exercise tests*. These tests are used for the diagnosis of coronary disease, and also for the assessment of the *physical condition* of the healthy or ill subject.

These exercise tests must only be carried out in the department of a hospital, having at its disposal resuscitation equipment, as they can be dangerous for some individuals.

The technical notice gives comments on several exercise tests:

(a) Master exercise test

The method is as follows: The subject makes a given number of trips across two standard steps in accordance with age, sex and weight. Each of the two steps is 9 inches high (23 cm), 8 to 10 inches deep and 18 to 27 inches wide. An ascent or trip is made by going up one side of the two steps and down the other. The return trip constitutes the second ascent. With a single two-step test, the number of ascents must be completed in a minute and a half; with the double two-step test, twice the number given for the single test, the number of ascents is completed in three minutes. The rhythm of ascents is controlled by a metronome.

(b) *Bicycle ergometers*, with adjustable but constant load for any speed of pedalling use electromagnetic braking systems acting on a fly-wheel.

(c) *The treadmill* has the advantage of requiring a walking activity which is more natural than pedalling. But treadmills are noisy, and expensive, their maintenance can be a source of difficulty.

In the conduct of these tests, the "step" method is used. The load is periodically increased; the rate of increase is chosen to be 10 watts each minute and the load is increased by 30 watts every three minutes. These tests are called "sub-maximal tests", for they are systematically stopped when the heart frequency reaches a percentage, fixed beforehand, of the theoretical maximal frequency ($220 - \text{age}$).

Electrocardiography is recorded during exercise tests. The ECG lead system is the CM5 (chest 5, manubrium). The electrode M is connected to the lead used for the right arm, the electrode C5 is connected to the lead of the left arm and the commutator is in D1 position.

Interpretation of the abnormalities which are recorded during exercise tests requires care. A negativation or a flattening of the Wave T is not specific in cases of ischemia and has not the same pejorative value as a negative depression, but the depression of the ST segment can give false positive results.

(3) *Germany*

In the regulations of 1969, a MASTER test is always carried out for a period of 3 minutes on every candidate for entry into the Air Force. This test is not mentioned in the regulations of 1976. An electrocardiogram is made before the exercise, the subject being at rest, then immediately on completion of the exercise, and finally two and four minutes after the end of the exercise.

If the past medical history and the results of the clinical examination show the possibility of orthostatic disturbances, an orthostatic tolerance test (tilt table test) must be carried out, with a recording of pulse rate and blood pressure.

A dynamic tolerance test, during which the pulse and blood pressure are read, is performed whenever hypertensive circulatory disorders are suspected.

Exercise tests to determine functional performance in hypoxia conditions are not mandatory. They are carried out at the German Institute of Aviation Medicine as part of the initial medical examination if there are any particular signs of aeromedical importance present, such as signs of circulatory disorders, orthostatic insufficiency accompanied by syncopal tendencies, or excessive dysfunctioning of the autonomic nervous system.

Any reduction in performance capacity is measured quantitatively in a low pressure chamber at a simulated altitude of 7,500 metres, using the ball test. This consists in placing 30 round objects in the appropriate holes. The heart rate, blood pressure and respiratory rate are recorded before the test, and then during the test while the subject is breathing 100% oxygen, and then while breathing the normal air in the chamber. The results are assessed according to the type of response given by the subject and the type of deterioration in performance in low oxygen conditions.

(4) *United Kingdom*

The regulations *prescribe* an exercise test for investigation of the cardiac function. With reference to this "exercise tolerance test" the RAF Manual states that a test of this kind rarely provides information which cannot be obtained during the general medical examination, that it is of no value in detecting heart disease, but is useful in special cases, usually to confirm the results of other parts of the examination.

The test is a *step-test*, lasting for one minute; the chair, which has to be mounted twenty times is at least 15 inches high. The pulse is taken before the test, then immediately after the test and, finally one minute after completion of the test.

The pulse rate immediately after the test should not exceed by more than 36 beats per minute the sitting pulse taken with the subject at rest before the exercise. One minute after the completion of the exercise the heart rate must have returned approximately to normal level.

Abnormal results are found in the case of emotional subjects, and as a result of some functional defects, such as insufficiency of systolic output, poor vasomotor tone or functional insufficiency of the circulatory system as a whole.

(5) *Canada*

Candidates for aircrew duties and trained aircrew who do not fully meet the fitness standards are referred for decision or opinion to the Defence and Civil Institute of Environmental Medicine. The regulations mention that this Institute has a low pressure chamber, a human centrifuge and various devices for testing cardiovascular stress. A description of these tests is not, however, included in the regulations on fitness standards for aircrew.

(6) *United States of America*

The exercise test *prescribed* in the regulations of the three US Forces consists in hopping 100 times on one foot, raising it about one inch from the floor at each hop. The sitting pulse rate is recorded before exercise, then immediately after, and finally two minutes after completion of the test. Blood pressure is read before the exercise and two minutes after the exercise. The degree of dyspnea, the possible existence of a murmur, as detected during auscultation, and any symptoms of circulatory failure are also noted.

The regulations again add that if *other tests* are carried out, their results should be noted.

No other exercise tests are especially recommended in the regulations of the USAF, the US Army and the US Navy. But, from AGARDograph 196, it can be deduced that the tests mentioned in the French regulations are also in common use in the US Forces, as they are in the other NATO Air Forces.

The US Navy Manual mentions that the neurocirculatory efficiency test (Schneider index) is no longer required. There is no objection to its being applied and noted, but it is no longer mandatory for assessing fitness for flying duties.

(b) **Diseases Providing Grounds for Unfitness for Flying Duties, in the Selection Examination**

Generally speaking, and without paying too much attention to details which are not of essential importance, it can

be said that there is good agreement between the various regulations in listing the diseases which provide causes for the rejection of candidates.

The following are causes for rejection:

1. Arterial or arteriovenous aneurysm.
2. Well characterised organic diseases of the heart and vessels; well characterised functional disorders of the heart.

In addition to diseases of the pericardium, the myocardium and the endocardium, this heading should also include, in particular, orthostatic tachycardia and hypotension, neurocirculatory asthenia, cardiac rhythm disturbances and intra-cardiac conduction disorders of pathological significance (see "Electrocardiogram" above).

Marked differences between the requirements of the various regulations should, however, be pointed out in the following cases:

(1) *Rheumatic fever* (Bouillaud's disease)

Disagreements between the various texts relate to the decisions to be taken in the absence of any cardiac sequela after one or more attacks of rheumatic fever.

Four regulations state that even in the absence of any cardiac sequelae subjects must be assessed as unfit for a minimum period of *two years* during which they must remain free from any symptoms.

The regulations referred to are those of the *USAF*, the *US Navy*, *Belgium* and *Norway*.

The *US Army* regulations require a candidate to be assessed as unfit until a period of *five years* has elapsed without the appearance of any symptoms. The *UK* regulations lay down a distinct and clear rule for such cases. If a candidate has a history of rheumatic fever, without cardiac or other sequelae, he can be accepted for flying duties if any of the following conditions apply:

- he is aged 25 years or over;
- he is under the age of 25 years, but has received for five years continuous penicillin prophylaxis, or it is *10 years* or more since the attack, no treatment having been given.

The *French* and the *Canadian* regulations are not explicit about the action to be taken in the absence of any cardiac sequelae. They simply state that cases of rheumatic fever with cardiac complications must be assessed as unfit. The *German* regulations are similarly imprecise: they specify that a history of acute or chronic rheumatoid arthritis is a cause for disqualification, either temporarily, or permanently, but no mention is made of the decision to be taken in the specific case of the absence of cardiac sequelae in subjects with a history of rheumatic fever.

(2) *Congenital diseases of the heart and heart surgery*

Three degrees of strictness are found

(a) *First group*: candidate to be assessed as unfit: no exception.

The *Belgian* regulations state that congenital heart diseases are causes for permanent unfitness, except dextrocardia with complete situs inversus, considered an anomaly and not a malformation.

The *French* and *German* regulations have similar provisions: congenital or acquired cardiopathy and malformation of the aorta and the major vessels, of whatever type, even after surgery, are grounds for permanent unfitness. The same requirement appears in the *US Army* regulations.

(b) *Second group*: candidate to be assessed as unfit, *except* in the case of minor congenital diseases, but these are not specified.

The *USAF* and *US Navy* regulations stipulate a decision of unfitness for any history of heart surgery and any *serious* congenital anomaly. Uncomplicated dextrocardia and other minor asymptomatic anomalies are acceptable. It should, however, be observed that neither of these two regulations defines what is to be understood by "minor asymptomatic anomaly". Candidates must be assessed as temporarily unfit for a period of at least six months after undergoing surgery for these minor anomalies.

The *Norwegian* regulations are similar to those of the *USAF*.

The *Canadian* regulations require an assessment of unfitness for cases of major congenital cardiopathy. Minor congenital diseases, however, which have been treated surgically, with results considered by a cardiologist to be satisfactory, are acceptable.

(c) *Third group*: candidate to be assessed as unfit except in the case of some well-defined minor congenital diseases corrected by surgery.

The *RAF* regulations are very precise. Congenital malformations of the heart and major vessels are, as a general rule, causes for rejection. Certain congenital malformations of the heart are, however, compatible with

acceptance for flying duties if a surgical operation has successfully eliminated their effects. The anomalies included in this category are the following:

1. *Patent ductus arteriosus*

If the patent ductus arteriosus has been permanently closed, either by ligation alone, or by ligation and division, the candidate can be accepted.

2. *Atrial septum defect*

The primary type is always unacceptable. In the secondary type, if the interatrial communicating orifice has been closed and there is no pulmonary hypertension or cardiac enlargement, the candidate can be accepted.

3. *Coarctation of the aorta*

A subject who has undergone a surgical operation for coarctation of the aorta can be considered fit for acceptance for flying duties only if the following requirements are met:

- the surgical operation was performed successfully more than 5 years previously;
- the clinical examination reveals no anomalies in regard to blood pressure, ECG and heart size;
- the femoral pulse is palpable and not delayed.

3. *Diseases Indicating Serious Functional Insufficiency of the Venous System*

The texts on varicose veins in the lower limbs are the subject of descriptive comments in some of the regulations, in order to determine the fitness requirements.

In the *Belgian* regulations, to constitute grounds for an assessment of unfitness for flying duties, varicose veins in the lower limbs must have at least one of the following characteristics:

- (1) be predisposed to rupture, either as a result of a trauma, or of haemodynamic changes during flying;
- (2) be sinuous or voluminous to the point of forming a tumour;
- (3) come at least halfway up the leg or extend beyond the knee.

The *French* regulations do not go into these details, but are confined to a statement that *marked* disorders of the peripheral venous circulation are causes of unfitness. They do, however, add an important detail which is missing from the *Belgian* regulations: varicose veins which have been treated surgically are not compatible with fitness for functions requiring the general medical aptitude standard No.1.

Varicose veins which have been treated surgically are compatible with the general medical aptitude standard No.2 (see Annex 1), if any functional or trophic troubles are absent and if they have no tendency to recurrence.

The *USAF* regulations do not state what is meant by "serious disorders which constitute grounds for rejection".

They enumerate some consequences arising out of these marked disorders: oedema, skin ulceration or scars resulting from previous ulcerations. They make no mention whatsoever of what happens if the varicose veins have been treated surgically.

The *US Army* and *US Navy* requirements are exactly the same as those of the *USAF*. The same applies to the *Norwegian* regulations.

Germany and *Canada* simply quote varicose veins to a marked degree among the causes for rejection, and similarly in the case of varicose ulcers. In parallel with the American regulations these countries provide no guidance for the assessor when confronted with a candidate whose varicose veins have undergone surgical treatment.

The *UK* regulations on the other hand do envisage this hypothesis, but the decision involved is the opposite of that in the *French* regulations. Any candidate whose veins show varices to any marked degree is assessed as unfit for flying duties until such time as this condition has been successfully corrected by means of surgery.

In conclusion, it is surprising to note that in regard to this relatively current condition the regulations do not agree on important details, though they all certainly prescribe rejection of a candidate when the varicose condition is very *marked*. Precise criteria in regard to this 'marked degree' are given in the *Belgian* regulations. The other regulations do not define the marked degree which is the cause of unfitness; only the *USAF* regulations add a reference to a few complications which are a frequent attribute of a marked degree of the varicose condition. Surgical treatment of the varicose condition is mentioned in two regulations only, although they differ in the requirements laid down.

In the *French* regulations, such treatment does not affect in any way the decision to declare the candidate pilot unfit. In the *UK* regulations, it makes the candidate fit for flying duties provided the operation is considered to have been successful.

B. PERIODIC MEDICAL EXAMINATION

(a) Basic Factors for Assessing the Circulatory Function

Pulse rate, ECG and physical exercise tests are not covered by any particular requirements which are fundamentally different from those for the initial examination.

It should be pointed out, however, that when referring to *electrocardiography*, the *USAF* regulations state a very wise precaution clearly intended to avoid premature or insufficiently founded or too radical decisions in regard to trained aircrew: all borderline tracings, those which differ markedly from those recorded during previous periodic examinations and those considered to be abnormal by the *USAF* Central Electrocardiographic Library are causes for declaring the candidate *temporarily* unfit and require detailed investigation. An assessment of fitness is restored only if the results of such an investigation carried out by the *USAF* School of Aerospace Medicine eliminate the existence of any cardiac disease.

The area of normality for *blood pressure* is widened in the majority of the regulations which fix numerical values to indicate the hypertensive condition boundary.

The maximum systolic and diastolic pressures are not considered to be abnormally excessive unless they are higher than the following values:

1. *Belgian Regulations*

160 mm Hg – 90 mm Hg

2. *USAF, US Army, US Navy Regulations – Norwegian Regulations*

140 mm Hg – 90 mm Hg, if the subject is 35 years old or under;

150 mm Hg – 90 mm Hg, if the subject is over 35 years old.

3. *German Regulations*

150 mm Hg – 95 mm Hg, if the subject is 35 years old or under;

160 mm Hg – 95 mm Hg, if the subject is over 35 years old.

4. *Canadian Regulations*

150 mm Hg – 90 mm Hg.

5. *French Regulations*

150 mm Hg – 90 mm Hg.

6. *United Kingdom Regulations*

No specific value is quoted, but it can be inferred from the explanatory notes that the maximum values are:
150 mm Hg – 90 mm Hg.

With reference to the *exercise tests* no precise statement of a mandatory nature is made that they should be modified in relation to the age of the subject or to the particular conditions of the periodic examinations.

Of all the functional tests quoted in connection with the initial examinations only the very strenuous endurance tests would, in fact, need to be adapted in relation to the specific purpose of the investigation for which they are being performed.

It should be noted in this respect that the 5 minute step-test is performed in the Belgian Air Force only as part of the *initial examination*. In the routine periodic examination it is replaced by 20 flexures of the legs.

The other functional tests (3 minute Master step-test, 1 minute Harvard step-test, orthostatism test, tilt table test, performance capability in low oxygen conditions, tests using ergocycles or treadmill) are suitable both for the periodic and the initial examinations, in the sense that they can be performed without running excessive risks in the case of subjects who have minor defects or who experience difficulties due to age.

(b) Diseases Constituting Grounds for Unfitness for Flying Duties

The position admitted by all regulations can be summarised by quoting the *German* regulations on the standards required for the periodic examinations. These standards are most frequently the same as the selection standards; some are less stringent, providing flight safety is not endangered and the pathological conditions revealed are marginal and not liable to be aggravated by flying.

Some comments on a few diseases should now be made.

1. *Coronary Artery Disease — Myocardial Infarction*

All the regulations require rejection of aircrew who have suffered coronary artery disease or myocardial infarction. Electrocardiographic evidence of sequelae constitute a sufficient basis for an assessment of unfitness.

2. *Sequelae of Rheumatic Fever*

The same standards are applied as for the initial examination.

3. *Heart Surgery*

The standards for the initial examination also apply to the periodic examinations.

4. *Varicose Conditions*

The standards for the periodic examinations are exactly the same as for the initial examination, except in the French regulations which run parallel in this respect with the British regulations. In the French regulations, contrary to the requirements for the initial examination, for candidate pilots, it is accepted that varicose veins which have been operated on are compatible with the maintenance of fitness for flying duties in trained aircrew providing there is no associated functional or trophic disorder and no tendency to recurrence of the varicose condition.

C. CONCLUSIONS

(a) *Radiographic and electrocardiographic examinations* are now essential additions to the clinical examination: they are mandatory in all the regulations, both for the initial and the routine periodic examinations.

(b) With regard to *exercise or functional tests*, they are mentioned in all the regulations. The assessment examination must therefore include them as *current* and sometimes mandatory elements. Instructions regarding examination methods occasionally specify precisely the tests which should be performed and in such cases they also indicate how the results are to be interpreted. More often than not, the regulations make no mention of methods of examination, although these are covered by separate special instructions (see AGARDograph No.196 quoted above).

In actual fact the functional tests, which are applicable to the examination for fitness for flying duties, constitute the *dynamic* part of the examination which must necessarily and as a *mandatory requirement* supplement the *static* examination. There is of course no master test, and everyone agrees on this point. Because of this it has always been difficult to state categorically which types of circulatory functional tests should be adopted. The lack of precision found in this connection is therefore not surprising, although regrettable. The essential point has, at least, been achieved: the inclusion of functional tests in the medical fitness examination. Furthermore, the warning given by the US Navy when referring to the Schneider test is a wise one. This test, like many others, has its limitations; it assesses in particular the effect of the autonomic nervous system on the control of the cardiac centres rather than the functional value of the myocardial fibre. The regulations rightly instruct the medical examiner not to rely on the quantitative results of this test *alone* in order to support a decision of unfitness. At the same time the doctor is reminded, as also in the case of the UK regulations, that the clinical examination of an individual constitutes a complete picture, of which it is often not easy to make an overall assessment, and that this difficulty cannot be made to disappear by the expedient of the results of a single test, sometimes of disputable or doubtful significance. A functional test provides an additional element among many others in a complete whole, but it must not be interpreted on its own and within its limits alone.

(c) *Pulse and blood pressure* readings are interpreted in very similar ways, which can be considered as practically the same. Some regulations lay great stress on the purely *indicative* character to be attributed to the values quoted as the normal levels.

(d) The *electrocardiogram* is dealt with in all the regulations, except those of the UK, by a precise enumeration of the abnormalities which give cause for rejection and those which are compatible with fitness. No serious divergence in the points of view expressed in the various regulations was found.

(e) With regard to the effect of some *diseases* on unfitness for flying duties, this is clearly an area requiring greater standardisation in the decisions made by medical experts, for example in the case of rheumatic fever, with and without cardiac sequelae, congenital heart diseases, sequelae of heart surgery and such ordinary diseases as varices.

CHAPTER V

ABDOMEN AND OESOPHAGOGASTROINTESTINAL SYSTEM

As a general rule all the regulations require anatomical and functional soundness of the digestive system and its adnexae. Minor morphological anomalies and sequelae of minor operations (e.g. appendectomy) are however compatible with fitness.

The regulations of the three American Services give a very *detailed* list of the diseases which, by their presence, or because of their past history, constitute grounds for rejection for flying duties. This negative facet is less pronounced in the Belgian, German and Canadian regulations, which confine themselves rather to a list of *groups* of diseases which are incompatible with fitness. The French and the UK regulations are even more sparing of details and are restricted to general principles and a statement of a few exceptions or special cases.

A. INITIAL EXAMINATIONS

(a) Past History

Some cases of past history are causes for immediate rejection in all the regulations. Others are compatible with fitness, subject to certain reservations.

1. *History of Gastroenterostomy, Gastric Resection, Intestinal Resection or Surgical Intervention for Intestinal Adhesions*

These cases, except appendectomy, and surgical intervention to relieve pyloric stenosis, when performed in the first weeks of infancy and when there is no functional sequela, are cases for the rejection of candidates at the initial examination in all the American regulations and also in the Canadian, Belgian, French, German, British and Norwegian regulations.

The British regulations sum up perfectly the general rule: "A candidate who has undergone an abdominal operation, other than a simple appendectomy, involving extensive surgical intervention or partial or total excision of an organ is, as a rule, unsuitable for flying duties."

2. *History of Gastric or Duodenal Ulcer*

A history of a gastric or duodenal ulcer entails the rejection of aircrew candidates for all flying duties, according to the American, Norwegian, Belgian, Canadian and German regulations. The same holds true for the UK regulations, which do however add a point of detail by limiting the period of time to be taken into account in the case of such history. It is in fact stated that candidates who are suffering at the time of the examination, or who have suffered during the previous *five* years from peptic ulceration or chronic indigestion should not be accepted.

The French regulations present a particularly interesting feature in that they contain different requirements depending on the type of flying duties involved.

It is only to meet the Class 1 general medical fitness standard that the absence of a history of a gastric or duodenal ulcer is absolutely essential on enlistment. In practice a subject with a history of a gastric or duodenal ulcer cannot be accepted as a candidate for training as a pilot — all categories, nor as a candidate for training as a transport aircraft pilot. He can, however, be accepted as a candidate for training as a navigator, bomb-aimer, radar operator, navigator of a transport aircraft, flight engineer, military reserve pilot or air gunnery observer, flying personnel of the light aviation of the Army and the Gendarmerie, and, in the case of women, as a candidate for training as a female flight attendant, if the candidate meets the distinctly less rigorous requirements of the Class 2 general medical fitness standard. This standard contains the following provisions:

- (1) Any subject with a history of *gastric* ulceration can be accepted only if a period of at least *one* year has elapsed since clinical recovery and the disappearance of any radiological evidence.
- (2) Any subject with a history of *duodenal* ulceration can be accepted only if a period of at least *one* year has elapsed since the disappearance of any clinical evidence, even if there is still radiological evidence of sequelae in the form of a scar.

3. *History of Gastrointestinal Haemorrhage*

This is a cause for rejection in all the regulations unless proved to have been due to a *single* episode of acute gastritis or an ulcer of Meckel's diverticulum which afterwards has been surgically resected, or to an acute infectious process which has completely resolved. These perfectly justifiable exceptions are quoted in the text of the USAF regulations.

4. *History of Cholecystectomy*, with residual functional sequelae or symptoms indicating post-operative stricture of the common bile duct or reforming of stones in the bile ducts or hernia at the place where the incision was made.

All the regulations require candidates with this history to be assessed as unfit, although the UK regulations, it is true, are not very explicit on the decision to be taken in such cases. This is, however, a special case of a major surgical intervention or the partial or total excision of an abdominal organ, which falls within the above-quoted general rule found in the UK regulations when referring to a history of abdominal operations (see under 1.).

5. *History of Splenectomy*

This is always a cause for rejection of a candidate, except when the splenectomy was required for trauma, the spleen being otherwise healthy.

All the regulations agree on this point.

The USAF regulations allow two other exceptions to this rule, which are very rarely encountered: cases in which a splenectomy was required because of hereditary spherocytosis, or a disease involving the spleen, which has been corrected for a period of at least two years (see (b) below).

(b) *Diseases Affecting the Abdominal Organs*

The various regulations all agree on the rejection of candidates who are suffering, at the time of the examination, from acute or chronic diseases of sufficient severity to prejudice the anatomical or functional soundness of the organs involved.

The following list is confined to some of the most frequently found diseases or anomalies:

- oesophageal diverticulum; stenosis of the oesophagus;
- chronic or recurrent oesophagitis; oesophageal reflux with hiatal hernia;
- *chronic gastritis*;
- ulcer of the stomach or duodenum, if the diagnosis is confirmed by X-ray examination or by a verified history;
- tumour of any part of the gastrointestinal system, unless when removed it is shown to be benign, and does not result in any post-operative dysfunction;
- gastrointestinal haemorrhage, (see (a) 3. above for history);
- chronic enteritis;
- ulcerous colitis;
- chronic diarrhoea, regardless of cause;
- megacolon;
- diverticulitis;
- hepatitis with the preceding six months, or more than six months if there is a persistence of symptoms with or without objective evidence of impairment of the hepatic function;
- chronic disease of the liver, whether congenital or acquired;
- hepatomegaly from whatever cause;
- cholecystitis, acute or chronic, with or without cholelithiasis, if the diagnosis is confirmed by the usual laboratory procedures or medical records;
- biliary lithiasis;
- biliary dyskinesia;
- pancreatitis, acute or chronic; history of pancreatitis;
- chronic splenomegaly;
- splenectomy for any reason except the following:
 1. trauma affecting an otherwise healthy spleen;
 2. hereditary spherocytosis;
 3. disease involving the spleen, but which has disappeared for a period of at least two years;
- inflammation of the rectum;
- extensive prolapse or considerable stricture of the rectum or anus;
- faecal incontinence;
- artificial anus;
- fistula or fissure of the anus;

- any other fistula of visceral, spontaneous or operative origin;
- ischiorectal abscess;
- external haemorrhoids that cause marked symptoms, or internal haemorrhoids that bleed or protrude, permanently or intermittently.

(c) Abdominal Wall

The following are causes for rejection in all the regulations:

1. Injuries, deep-seated wounds of the abdominal wall or weakness of the muscles of the abdominal wall, when sufficient to interfere with function.
2. Hernias of all kinds, except small asymptomatic umbilical or hiatal hernia. Surgical repair of a hernia makes a candidate temporarily unfit for at least 60 days in the American regulations, and at least 90 days in the French regulations.

The French regulations extend this decision to other operation scars, by specifying in addition, and with great clarity, the types of scars which are compatible with flying duties. Scars following appendicectomy, radical repair of hernia or any other minor operation are not causes for unfitness providing they are flexible, non-adhesive and are not distended by coughing, and providing also that the surgical intervention was performed more than *three* months previously.

B. PERIODIC EXAMINATIONS

The standards on which unfitness is based at the initial examination apply also to the periodic examinations. The American regulations refer again in particular to the fact that any gastrointestinal haemorrhage, from whatever cause, entails an assessment of unfitness.

Some requirements, characterised by greater flexibility or greater precision in the details for their application, are, however, laid down for peptic ulcers, hernia and viral hepatitis found during a periodic examination.

(a) Peptic Ulcers

The various regulations show many points in common. The few differences noted relate merely to points of detail such as the *minimum period of unfitness*, or fitness with certain limitations, following a surgical operation, or unfitness for certain flying duties while remaining fit for other duties (French regulations).

1. *USAF Regulations* (identical with those of the *US Army*, the *US Navy* and the *Norwegian Air Force*)

- (1) Single or recurrent peptic ulcers *not* complicated by haemorrhage, perforation or obstruction constitute grounds, *in principle*, for rejection for flying duties. However, waivers may be granted by the competent medical authority if the following six conditions are present:
 - absence of symptoms;
 - healing demonstrated by X-ray examination, without residual spasm, irritability or duodenitis;
 - absence of the continuing need for medications, such as sedatives, anti-spasmodics or other agents which are contra-indicated for flying duty;
 - absence of continuing need for special food or for eating at frequent intervals;
 - absence of cirrhosis, oesophageal varices, neoplasm, erosive gastritis, hiatal hernia or familial telangiectasis;
 - the medical examiner must prepare a statement certifying that the subject understands the factors which affect recurrences and complications.
- (2) Peptic ulcers, recurrent or otherwise, which are *complicated* by haemorrhage, perforation or obstruction are *always* reasons for rejection.
- (3) After surgical treatment, an assessment of fitness may be made under the special waiver procedure. Before submitting the case to the appropriate medical authority, the surgeon who performed the operation and the Flight Surgeon who examined the airman and brought the case before the competent medical authority must have found the subject qualified to resume his flying duties without medication and without the need for any unusual diet.

The regulations do not state the minimum period which should elapse between the operation and the initiation of the procedure for assessing him as fit.

2. *French Regulations*

The particular feature of these regulations is the introduction of the concept of fitness limited to the performance of certain duties, with possible unfitness for other duties involving greater responsibility or demanding a higher standard of physiological fitness, or subjecting the airman's organism to more intense mental stress.

- (1) Any subject who has suffered from a gastric or duodenal ulcer no longer meets the Class 1 general medical fitness standard, that is, he is unfit as a jet fighter, reconnaissance or bomber pilot. He can, however, be assessed as fit under the Class 2 general medical fitness standard which allows him to undertake the duties of pilot of a transport aircraft, a bomber aircraft of conventional type, a twin-engined communications aircraft, a helicopter, a liaison aircraft, a single engined aircraft, a light aircraft, or to remain as a reserve pilot and ab initio flying instructor pilot, or else to act as navigator, bomb aimer, radar operator, transport aircraft navigator, radio navigator, aircraft radio operator, air gunner observer, flight refueler, flight engineer, flying personnel of the light aviation of the Army and the Gendarmerie, or, in the case of women, as a female flight attendant. However, this Class 2 grading can be granted only if a period of *at least one year* has elapsed since clinical healing of the gastric ulcer and the absence of radiological evidence, or since the clinical healing of the duodenal ulcer, even if an X-ray shows sequelae in the form of a scar.

If the subject has received surgical treatment he may retain a fitness limited to a Class 2 grading only if a period of at least *one year* has elapsed since the operation and if post-operative effects no longer appear likely to render him suddenly incapacitated during a flight.

- (2) A recurrence of a gastric or duodenal ulcer (chronic ulcer) entails permanent unfitness.

3. *German Regulations*

These are not very detailed. They present no new feature and follow the general lines of the American regulations.

A gastric or duodenal ulcer entails unfitness for flying duties. Following surgical treatment, the subject remains temporarily unfit for at least *six months*. The final decision depends on the degree of functional recovery.

An ulcerative chronic disorder is a cause for an assessment of permanent unfitness for flying duties.

4. *Canadian Regulations*

These are less stringent and not so precise as the American regulations, although they are very similar to the latter.

(1) *Acute ulcer without complications*

When an acute peptic ulcer without haemorrhage or perforation is suspected, and when the X-ray examination is completely negative, it is impossible to establish a definite diagnosis. In such cases the subject can be assessed as fit to continue his flying duties until further information is available.

(2) *Confirmed acute ulcer with complications*

If an X-ray examination confirms the existence of an ulcer and if the observed symptoms are associated with haemorrhage or perforation, the patient must be hospitalized. After treatment and a period of convalescence, he must be given a limited fitness standard only; (to fly with, or act as, co-pilot; duration of flights limited to 4 hours). If, after this period, which lasts *six months*, the subject is symptomless without medication or dietary restrictions, he may be permitted to return to full flying duties.

(3) *Ulcerative chronic disorder* (chronic or recurrent ulcer)

A limited flying category is awarded in the period preceding surgical treatment.

In the case of student pilots, an ulcerative chronic disorder entails permanent rejection for flying personnel.

(4) *Surgical treatment*

Restoration of a full flying category is possible *three months* after the operation.

5. *UK Regulations*

These do not lay down any hard and fast rule, but are confined to statements giving general guidance.

- (1) If medical treatment has produced complete freedom from symptoms in cases *not* complicated by haemorrhage, the subject may be assessed as fit *six to nine months* after clinical healing of the ulcer, but with flying duties limited to temperate climates.

It is recommended to proceed by stages, starting with three months' ground duty and then three months' flying duties with strict limitation of the duration of flights.

- (2) If the subject has received surgical treatment he may be permitted to return to flying duties, limited geographically to the UK, *six months* after the operation, if he is following a normal diet. *Twelve months* after the operation he may be allowed to return to full flying duties providing he is on a normal diet and the results of checks are satisfactory.
- (3) Patients with *chronic* gastric or duodenal ulcers complicated by haemorrhage are assessed as permanently unfit for flying duties.

6. *Belgian Regulations*

These are similar to the UK regulations. They too lay down no hard and fast rules but state general principles which are not mandatory.

- (1) If medical treatment or simple suture of a perforated ulcer in cases not complicated by haemorrhage has produced complete freedom from symptoms, a return to flying duties with limitations on the duration and the nature of the flights can be authorised after a period of from *six* to *twelve* months without the re-appearance of any symptoms.

Permission to remain in tropical climates is subject to freedom from all symptoms for a period of *two* years and the ability to take full diet.

- (2) If the subject has undergone gastrectomy or gastroenterostomy, authority to return to flying duties, with limitations on the duration and the nature of the flights, can be given only after a period of at least *six* months following post-operative healing and the resumption of a normal diet. An assessment of unrestricted fitness can be given only after a period of healing of at least *twelve* months.

- (3) In cases of ulcers complicated by haematemesis or melaena, any assessment of fitness for flying duties with limitations can be given only if clinical healing has been confirmed for at least *six* months.

(b) *Hernia and Weakness of the Abdominal Wall*

1. *USAF, US Army, US Navy and Norwegian Air Force Regulations*

Following surgical repair of inguinal hernia, an assessment of temporary unfitness, for a period of at least 60 days, is made until recovery is complete and there is no limitation on physical activity.

2. *French Regulations*

All types of hernia and weakness of the abdominal wall, as well as deep-seated abdominal scars, are disqualifying for all flying duties. Scars following radical repair of hernia, appendicectomy or any other minor operation, when they are flexible, non-adhesive and are not distended by coughing, and providing the surgical intervention was performed more than *two* months previously, need not entail unfitness. The same applies to scars of injuries affecting only the abdominal wall and presenting the same characteristics.

3. *German Regulations*

Hernias of all types are causes for an assessment of unfitness until the scar from the surgical repair is sufficiently strong to withstand stress.

Scars which are not sufficiently strong to withstand stress, or any weakness of the muscle of the abdominal wall, entail unfitness.

4. *Canadian Regulations*

After surgical repair of a hernia the subject is assessed temporarily unfit for a minimum period of 90 days.

5. *Belgian Regulations*

All types of hernia, recurrent hernia and hernial bulging are causes for rejection.

However, no precise minimum duration is laid down for the period of temporary unfitness following an operation for surgical repair.

6. *UK Regulations*

A very short note here: Any subject who has a hernia is unfit for flying duties until the hernia has been eradicated by a successful surgical operation.

(c) *Viral Hepatitis*

All the regulations agree on this point. Any subject with viral hepatitis is to be assessed as unfit until clinical healing is complete, the liver function is normal and physical activity is not limited.

C. *CONCLUSIONS*

The texts of the regulations under review show a good deal of uniformity and similarity.

Points of difference are few, and do not relate to fundamental questions. In most cases they differ in details which arise out of special directives in which flexibility in the decision to be taken has been one of the objectives aimed at.

The points which are worthy of mention are as follows:

(a) Surgical History Relating to the Digestive Organs

The cases of medical history which are causes for immediate rejection during the initial examination are clearly specified in precise texts in all the regulations.

On the one hand, any major abdominal operation or any partial or complete excision of an organ means that a candidate who has such a history cannot be accepted as an aircrew member. On the other hand, minor abdominal operations, the most general type of which is appendicectomy, or an operation for pyloric stenosis which the candidate has undergone in early infancy, are assessed in the same way in all the regulations: they do not preclude the candidate from being assessed as fit for flying duties.

(b) Peptic Ulcer at the Initial Examination

A candidate for training as a pilot who is suffering from, or who has suffered from a peptic ulcer is disqualified in all the regulations.

With regard to *other duties* performed by flying personnel, the same rule applies, but with one exception. This single exception occurs in the French regulations. Candidates suffering from a peptic ulcer *at the time* of the examination are disqualified. The regulations provide however that candidates with a past history of a gastric or duodenal ulcer can be accepted for duties other than those of pilot, providing a period of at least one year has elapsed since clinical healing of the ulcer with a complete absence of X-ray evidence, in the case of a gastric ulcer. This tolerance, with very precise limits, is in fact very restricted in scope, although it enables young people who are keenly motivated for a flying career, to be employed on flying duties which do not impose so great a nervous strain as that demanded of the student pilot during his training.

(c) Peptic Ulcer at Periodic Examinations

1. Peptic ulcers, whether recurrent or otherwise, which are not complicated by haemorrhage, perforation or obstruction are compatible with a return to flying duties after complete clinical recovery and absence of X-ray evidence. This is acceptable in all the regulations.

The conditions of such recovery are stated very fully in the USAF regulations.

However, with the exception of the three American regulations and those of the Federal German Republic and Norway this return to flying duties after recovery is not accomplished without due precautions which make it a gradual process.

Under the French regulations such aircrew are removed from duties as pilots of combat aircraft (jet fighter, reconnaissance or bomber aircraft).

The Canadian, UK and Belgian regulations state that such aircrew may be assigned a limited standard of fitness, with restrictions on the duration of flights and on residence in certain geographical areas. These restrictions extend over several months before a full standard of fitness can be restored. In addition, the regulations lay down minimum periods which must elapse between clinical recovery and the resumption of full flying duties. They are:

- 6 months in the Canadian regulations;
- 12 months in the French regulations;
- 6 to 12 months in the Belgian regulations;
- 6 to 9 months in the UK regulations.

2. Ulcerative disease (chronic and recurrent ulcers complicated by haemorrhage, obstruction etc.) is a cause for permanent unfitness in all the regulations.

3. If clinical healing has been achieved by *surgical treatment* with satisfactory results, the subject is assessed as fit for flying duties.

No minimum period between the operation and the decision to assess the subject as fit is stated in the American or Norwegian regulations. The other regulations contain the following details:

France: The Class 2 standard of general medical fitness is assigned if a period of at least *one year* has elapsed since the operation and if the results of the operation no longer appear likely to cause sudden incapacity during a flight.

Germany: The subject is graded temporarily unfit for at least *six months* after the surgical intervention.

Canada: After a *three months'* period of limited fitness, the subject may recover his previous full flying category, if healing is confirmed.

United Kingdom: An aircrew member can be given a category with *limitations*, six months after the operation. He may be permitted to return to *full* flying duties twelve months after the operation, providing healing is confirmed.

Belgium: A standard of fitness with *limitations* can be assigned six months after the operation. A full category cannot be restored until at least twelve months after the operation.

4. This comparative study shows how difficult it is to draw up rules for situations whose clinical development can so often vary unexpectedly from case to case. The impression is gained, however, that it might be possible to achieve greater agreement on the minimum period during which a subject should be assessed as temporarily unfit, and more particularly, on the length of temporary unfitness which should follow a surgical operation. This is an important point, since well motivated aircrew do in fact often resort to a surgical operation for treatment of their ulcerative disorder. Then, after the operation, it very frequently happens that they bring pressure to bear on the medical department to shorten the period during which they are assessed as temporarily unfit.

(d) Hernia and Weakness of the Abdominal Wall

Injuries and deep-seated wounds in the abdominal wall or weakness of the musculature of the abdominal wall, when sufficiently serious to interfere with function, are disqualifying causes in all the regulations, both at the initial examination and at the periodic examinations.

Operation scars after appendicectomy, radical cure of hernia or any minor operation, when they are simple, do not cause adhesions or are not distended by coughing, permit the assignment of a full fitness standard if a period of at least 60 days has elapsed since the operation, according to the American and Norwegian regulations. The same applies in the French regulations for the periodic medical examinations. This period is, however, increased to 90 days in the French regulations for the *initial* examination. A 90 day period is also found in the Canadian regulations, both for candidates for service and for trained aircrew members.

This period is not specified either in the German regulations, or the Belgian or UK regulations. It would therefore seem that, if a common basis is to be found someday for the purpose of standardisation, it might be possible to take 60 days as the minimum period to be allowed to the aircrew member for the healing of operation wounds before his return to flying duties.

Hernias of all kinds are disqualifying for all flying duties, except small umbilical or hiatal hernias. This is a rule which is common to all the regulations.

As stated above, surgical repair of hernia enables restoration of a full standard of fitness after a minimum period which varies, according to the regulations, from 60 to 90 days after the operation.

(e) Viral Hepatitis

No divergence of views exists in the various regulations, complete clinical recovery being the basis for a return to flying duties.

CHAPTER VI

GENITOURINARY SYSTEM

The general rule is that the genitourinary system should be anatomically and functionally sound.

Both the examination on initial entry into the Service and the subsequent periodic examinations always include, as a minimum requirement, a urine analysis for detecting the presence of albumen or sugar, with possibly an analysis of the density and the nature of the sediment. Some of the requirements do, in fact, involve microscopic examination of the urine.

Numerous anomalies and diseases of the kidneys, urinary passages and genital organs entail an assessment of unfitness: these are listed in great detail in the American regulations. This list, which has no counterpart in any of the other regulations, will not be repeated in this study. The seriousness and the development of these anomalies and diseases leave one in no doubt about the justification for an assessment of unfitness when found in the candidate for service or in serving personnel. Reference will be made only to special points on which there is a divergence of views, and to some aspects which call for comments which may be useful from a standardisation point of view.

A. ALBUMINURIA

The regulations fall into two groups, according to the radically opposite requirements in regard to *orthostatic albuminuria*.

(a) First Group

This group includes the regulations for the three American Services and those of Norway.

All types of albuminuria, if persistent or recurrent, including orthostatic albuminuria or functional albuminuria, are grounds for rejection.

(b) Second Group

This group comprises the regulations of all the other countries.

Persistent proteinuria is cause for rejection. The *Belgian* regulations state that persistent proteinuria is to be assumed if there is continuous albuminuria for three consecutive days, even if its cause cannot be determined. In additional instructions, a period of observation in the appropriate specialised unit of a military hospital is prescribed. This precaution is also mandatory in the French regulations.

Temporary proteinuria is compatible with fitness, in the case of orthostatic albuminuria.

In general, however, special instructions provide for a period of observation in a hospital unit to confirm or otherwise that it is actually a case of orthostatic albuminuria without pathological character (Belgium, France).

The German regulations published in 1969 give the following conditions as characteristic of orthostatic albuminuria, compatible with acceptance for flying duties:

- (1) absence of pathological elements in urinary sediment;
- (2) disappearance of the albumen excretion after remaining for a sufficiently long time in a horizontal position (the morning urine should be free of albumen if the subject has passed urine two hours after going to bed the previous evening). In cases of doubt clinical findings will always be verified by renal function tests.

The wording in the UK regulations is not as categorical as that in the regulations quoted above. It states: "When proteinuria is detected, further tests are required to decide whether the cause is other than orthostatic. Assessment will depend on the cause." Although this wording is not very explicit, it seems to suggest that albuminuria which has been confirmed as due to orthostatic causes can be considered as compatible with the performance of flying duties.

In Canada, proteinuria entails rejection, if other than orthostatic.

As already mentioned, the conclusion to be drawn from this review of regulation texts is that with regard to ortho-static albuminuria two distinctly opposite attitudes are adopted on the question of compatibility with flying duties.

B. HAEMATURIA, CYLINDRURIA, HAEMOGLOBINURIA

These conditions, which are considered as indicative of a disease of the kidneys or of the urinary tracts, are causes for rejection in all the regulations, if found in candidates for entry into the Service.

In the periodic examination, cases are considered according to the significance of such symptoms in relation to all the relevant clinical aspects.

C. GLYCOSURIA

(a) Persistent glycosuria, regardless of cause, including renal glycosuria, is disqualifying in all the regulations at the *initial examination*.

The French and UK regulations draw particular attention to its detection in candidates for service. For this purpose the French regulations require a test for the presence of sugar in the urine to be carried out after meals or after the subject has been given oral glucose loads in the morning. Any discovery of glycosuria must be followed by a test of provoked hyperglycemia. The UK regulations state that if glucose has been detected in the urine its significance should be confirmed by means of a test. After emptying his bladder, the subject is given 50 grams of glucose. His urine, passed one hour and one and a half hours later is then analysed. If no sugar is contained in either specimen, the candidate may be accepted; but if sugar is found, a glucose tolerance test is carried out before a final assessment is made.

The German regulations impose a glucose tolerance test in any examination. If the oral test is carried out, the subject must absorb 100 grams of glucose. Furthermore, a qualitative test for detecting the presence of sugar in the urine is also imposed at each examination. Marginal results, from the glucose tolerance test, must provoke deeper clinical investigations, mainly concerning the liver, the metabolism of lipids, the renal function, the skin, the eye fundus and the central nervous system, before any decision on fitness. Furthermore, in these cases, checks of glycosuria must be regularly performed on the urine collected during 24 hours.

(b) Periodic Examination

The majority of the regulations make no difference between the periodic and the initial examination. An exception to this rule is found in the French and Belgian regulations.

The Belgian regulations state that renal glycosuria should not constitute *in itself* a cause for unfitness for flying duties.

In the French regulations alimentary or intermittent glycosuria, the character of which has appeared to be reversible, either after further tests, or after a period under observation in a hospital, or after the use of an appropriate diet, is compatible with an assessment of fitness for flying. These provisions are similar to those of the UK regulations for initial and periodic examinations.

D. HISTORY OF NEPHRETIC COLIC – PRESENCE OF A CALCULUS

- i. The *presence* of a calculus in the pelvis of the kidney, the ureter or the bladder is a cause for rejection at the initial medical examination. At a periodic examination it is a cause for rejection for flying duties until it has been passed. All the regulations are in agreement on this point.
- ii. The same cannot be said, however, about the assessment to be made when there is a *past history of nephretic colic*.

(a) On Entry into the Service

All the regulations, with the exception of those of the UK, authorise the acceptance of candidates with a history of *unilateral* renal calculi or who have had a single attack of renal or ureteral colic. Acceptance is, however, only authorised under certain conditions which are practically the same in all the countries considered. These conditions are detailed below, as given in the USAF regulations:

1. the calculus has been passed and an X-ray examination shows no evidence of concretion in the pelvis of the kidney, the ureter or the bladder;
2. excretory urography shows no congenital or acquired anomaly;
3. renal function is normal;
4. the presence of parathyroid adenoma or a metabolic disorder can be excluded.

The attitude adopted by the UK regulations is somewhat different: it tends to a higher degree of strictness. Candidates for service who have a history of renal colic or renal calculi are *usually* rejected. As a point of good logic the regulations require a detailed investigation of the urinary tracts, including urography, before an assessment is made. Hyperalkalinity of the urine by excessive elimination of calcium, when present alone, requires the advice of a consultant before considering the acceptance of a subject.

The American regulations state that a history of *bilateral* renal calculi entails rejection both at an initial and at a periodic examination.

A past history of pyelotomy must have taken place more than 24 months previously, according to the American regulations, and more than 6 months previously, according to the German regulations, in order to be compatible with acceptance.

(b) Periodic Examination

Past history of urinary lithiasis may be compatible with fitness if the calculus has been passed, if the X-ray examination does not reveal any concretion in the urinary tracts, if the excretory urography shows no congenital or acquired anomaly and if the renal function is normal. All the regulations agree on this point. In some regulations these main facts are supplemented by detailed information.

For example, the Belgian regulations stipulate that, after the calculus has been passed, the subject should be assigned only a standard or limited fitness for two months and that the radiological, biochemical and bacteriological tests should be repeated at the end of six months.

The UK regulations stress the important factor of the excessive elimination of calcium in the urine. This factor does not by itself, however, constitute a reason for an assessment of unfitness for flying duties. If treatment of this condition prevents any recurrence of the renal calculus, the subject can be assessed fit for full flying duties, including service in tropical climates.

E. NEPHRECTOMY – ABSENCE OF A KIDNEY – RENAL PTOSIS

(a) Initial Examination

The absence or ablation of a kidney entails rejection in all the regulations. The same rule applies to renal ptosis.

(b) Periodic Examination

The requirements in the regulations differ markedly in regard to the decision to be made following a nephrectomy, and fall into the following groups:

1. First Group

A nephrectomy, for whatever reason, constitutes grounds for permanent unfitness. This is the view adopted in the American, Norwegian, Canadian, French and German regulations. The German regulations state that a history of pyelotomy is acceptable for fitness for flying.

2. Second Group

A nephrectomy after trauma entails suspension from flying duties for at least six months, after which the ban may be lifted if the remaining kidney is healthy and can assume its compensating role. In most cases, however, only a return to limited flying duties will be authorised. A nephrectomy due to any other cause entails permanent unfitness.

This group covers the Belgian and UK regulations.

Renal ptosis is a cause for rejection in all the regulations.

F. CHRONIC DISEASES

Chronic diseases of the kidney and urinary tracts, including the urethra, are all, including *chronic* gonorrhoea and its urinary complications, causes for rejection both at the initial and at the periodic examination, in all the regulations. Only the American regulations give a complete list of such diseases. However, acute or chronic urethritis, if without complications, and not of gonococcal origin, is compatible with fitness for flying duties.

Habitual or continual incontinence of urine at night is always a cause for rejection.

According to the German regulations, in periodic examinations, minor chronic prostatitis, slight hypertrophy of prostate and minor urethral structures with only minor urinary troubles are compatible with fitness.

In regard to the assessment to be made following *nephritis* or *pyelonephritis*, the German regulations lay down the conditions which must be satisfied before it can be considered that there has been complete clinical recovery and consequently that the subject is fit for flying duties. These conditions are as follows:

- (a) blood pressure must be normal;
- (b) urinary sediment must not contain any element of pathological significance;
- (c) clearance tests must provide normal results;
- (d) serological tests must give normal results with regard to the following:
 - potassium content;
 - sodium content;
 - residual nitrogen or urea content;
 - creatinine content;
- (e) Volhard's dilution and concentration test must give normal results;
- (f) there must not be any abnormal changes in the excretory urogram;
- (g) there must be no evidence of pathogenic germs of renal origin, during repeated microscopic examinations of the urine.

G. HYDROCELE – VARICOCELE

On the whole the texts are worded in a general manner and not very precisely, leaving the medical examiner a wide measure of freedom to exercise his own discretion.

The French regulations provide the best summary of the common positive aspect by stating that "slight atrophy of a testicle, or varicocele which is not large or painful, need not entail an assessment of unfitness".

The criteria of size and painfulness, in regard to hydrocele and varicocele, recur in almost all the other regulations to characterise the conditions which would entail rejection.

The US Army, US Navy and the Canadian regulations present a short text on general lines: varicocele and hydrocele are causes for rejection if large or painful.

The Belgian regulations introduce the concept of "interference incompatible with flying duties or military service". One of the provisions stipulates that "varicocele sufficient to cause interference incompatible with military service or flying duties must entail rejection". In another article it is stated that "chronic affections or lesions of the testicle, the spermatic cord or the scrotum, which have developed to the point of causing interference incompatible with military service or flying duties are causes for rejection".

The UK regulations are particularly vague: "Only rarely will hydrocele or varicocele affect the grading of the subject. Hydrocele may require treatment." In spite of its lack of detail this text would seem to imply that such conditions are rarely made causes for unfitness for flying duties. However, no mention is made of the criteria to be considered by the examiner in support of his assessments.

The USAF regulations, as also the Norwegian and German regulations, bring in a different and more precise note, with an element which is not found in any of the other regulations: the side on which varicocele occurs. Hydrocele and *left* varicocele, if large are painful, are causes for rejection. *Right* varicocele entails rejection unless the pyelogram is normal.

H. UNDESCENDED TESTICLE

The three American regulations and those for Norway, Germany, Canada and Belgium require the rejection of a candidate at the initial examination for undescended testicle. This extremely concise text is fortunately amplified in two of these regulations by details which remove all ambiguity. Under the Belgian regulations candidates are rejected if one or both testicles are retained at the external ring or in the inguinal canal, even if such retention is not permanent or painful when palpated. The Canadian regulations state that if the testicle is mobile enough to be capable of being brought down into the scrotum, this is not a cause for rejection.

The UK requirements are not precise: if the testicle is retained in the inguinal canal, at the external ring or in the abdomen, a surgical opinion must be obtained before making an assessment. No recommendations or definitive instructions are, however, laid down for the guidance of the examining medical officer.

The French regulations on the other hand do not contain any particular instructions in this respect.

I. DISEASES OR MALFORMATIONS OF THE MALE GENITAL ORGANS

From the more or less comprehensive list of diseases and malformations of the male genital organs, the following most frequently found conditions, which are causes for the rejection of candidates, should be quoted:

- (a) absence or pronounced atrophy of both testicles. However, unilateral testicular atrophy and monorchidism resulting from surgical operation and not presenting any functional symptoms or any clinical signs may be compatible with fitness;
- (b) hermaphroditism;
- (c) epispadias or hypospadias in the middle or at the root of the penis (Belgian regulations) or causing the soiling of clothes when voiding, or when complicated by infection of the urinary tract (American regulations);
- (d) tumours of these organs or a history of surgical intervention for such tumours.

In the periodic examinations, diseases of the male genital organs usually are a cause of temporary unfitness until complete healing.

J. GYNAECOLOGICAL DISEASES

Nurses and women flight attendants who are accepted as flying personnel in order to perform their duties during the evacuation of casualties by air must be free from past gynaecological history and gynaecological diseases likely to cause difficulties during the performance of their flying duties.

A detailed list of such diseases appears in the American regulations. The other countries confine themselves to stating a few general conditions. With regard to *pregnancy*, this is a reason for temporary unfitness in the American, Canadian, Norwegian and UK regulations.

The UK regulations provide very clear information, which is not found in any of the others, on the subject of the date of return to flying duties after delivery. Any candidate found to be pregnant is declared temporarily unfit for flying, the period of unfitness being extended for at least six months following the birth of a viable child. If the child is stillborn or dies after birth, this period can be reduced to three months, subject to a satisfactory gynaecological examination. These requirements do not apply to pregnancies which terminate before the 28th week if there are no complications and if a period of four weeks has elapsed since the termination of the pregnancy.

The Belgian, French and German regulations do not contain any clauses covering gynaecological diseases or pregnancy.

K. CONCLUSIONS

All the regulations bear witness to a complete agreement on the majority of the essential points in regard to renal and genitourinary pathology. It is therefore surprising to find radical differences on several points of special interest which are not in fact rare occurrences. The following are quoted as specific examples: orthostatic albuminuria, renal glycosuria, past history of nephritic colic, action to be taken after a nephrectomy.

In other areas, while some regulations formulate additional or explanatory criteria to avoid any ambiguity in regard to the assessments to be made by the examining medical officer, others are entrenched within such a degree of conciseness as to leave the door wide open to a diversity of interpretations and assessments; for example, a history of nephritis, hydrocele and varicocele compatible with an assessment of fitness, retention of the testicles in the inguinal canal.

Finally, very detailed requirements in regard to pregnancy and the return to flying duties after a normal or an interrupted pregnancy are contained in the regulations of one country only (United Kingdom).

The directives issued and applied in the Air Forces of the other countries to supplement the general texts on pregnancy contained in the regulations, exist quite certainly in the form of special instructions, separate from the official framework of the requirements for medical fitness for flying duties.

The reasons for this state of affairs are understandable in this connection: although the standardisation of strictly medical concepts relating to fitness for flying duties is an easy matter and exists de facto, the administrative aspect of the measures for implementing such concepts may present characteristics which differ widely from one Air Force to another.

CHAPTER VII

ENDOCRINES

Serious disorders of the endocrines, serious metabolic disorders, severe avitaminosis and persistent and important disorders of the nutritional function are causes for rejection.

Many main diseases under this heading are quoted in the American regulations. The Belgian regulations are also fairly detailed in this connection: it must be recognised that the nature, development, and seriousness of these disorders are such that they cannot give rise to the least doubt about their disqualifying characteristics once they have been diagnosed. Two conditions, however, require specific mention and comment.

A. GOITRE

- (a) In the *French regulations*, and also in *those of Belgium*, goitre, even euthyroid, is a cause for rejection.
- (b) The *American regulations* distinguish between simple goitre and thyrotoxicosis.
 - 1. Simple goitre is disqualifying if associated with pressure symptoms or if enlargement is of such a degree as to interfere with the wearing of military uniform or military equipment.
 - 2. Thyrotoxicosis is always a cause for rejection.

These requirements apply both at the initial and the periodic examination.

- (c) The *Canadian regulations*, both for flying and for ground personnel, make the same distinctions as the American regulations, but go further by also taking into account, at the periodic examination, the results of treatment for these conditions.

At the initial examination a history of Basedow's disease or thyrotoxicosis with a symptomatology of severe complications entails rejection.

At the periodic examination the following are causes for suspending an assessment of fitness until they have been cured:

1. Hyperthyroidism

The subject may be re-assessed as fit one year after thyroidectomy or three years after treatment with radioactive iodine, if the goitre is then euthyroid.

2. Simple Goitre

A euthyroid person who has had an operation and who remains euthyroid one year later may be re-assessed as fit.

- (d) Neither the *German nor the UK regulations* make such distinctions. They both rely on the good clinical sense of the examining expert to judge the seriousness of each case. Severe hyperthyroidism and hypothyroidism are causes for rejection in the German regulations. The UK regulations advise rejection of candidates with a recent history of hyperthyroidism which has been treated medically, because of the high risk of recurrence.

No mention is made of the decision to be taken at periodic examinations on subjects who have undergone surgical or radioactive treatment.

B. DIABETES MELLITUS

(a) Family History of Diabetes

- 1. At the initial examination, such a history constitutes grounds for rejection in the *French regulations*. The same

applies to the regulations for the three *American Services* and also the *Norwegian regulations*, if both parents have suffered from diabetes. These five sets of regulations form a *first group* of countries in which the existence of a family history is sufficient to require the rejection of the candidate.

The French regulations even specify the rule to be followed in case of *suspicion* of a family history of diabetes mellitus. "A family history of diabetes mellitus, a history or the existence of recurrent infected cutaneous lesions, the existence of micro-aneurysms in the eye fundus, or obesity will necessitate a test of provoked hyperglycaemia: any abnormal result is, in these circumstances, a cause of unfitness."

The tests for detecting glycosuria are carried out after a meal or after an oral glucose loading in the morning.

2. A *second group* is made up of the *UK* and *Belgian regulations*, which do not consider a family history as a reason *in itself* for rejection, but regard it as a warning sign, and urge the need for care and for detailed tests before any decision is taken.

The UK regulations *recommend* that, if both parents have such a history, a glucose tolerance test should be performed before acceptance is considered. If one parent or a sibling has diabetes, the candidate is required to undergo a 50 gram glucose loading test. If the degree of relationship to the diabetic person is more distant than a single parent or sibling, the family history can be ignored.

The Belgian regulations are more liberal minded than those of the UK: a past history of diabetes in the family is not a reason *in itself* for rejecting a candidate providing his own past history and present condition are satisfactory.

3. The *third group* consists of the *German and Canadian regulations*, which are silent on this problem of family history.

(b) Confirmed Diabetes Mellitus

1. At the *initial examination*, a confirmed diabetes mellitus is a reason for rejection in all the regulations.

2. At the *periodic examinations*, some differences of opinion are found only in regard to *mild* degrees of diabetes.

Type II diabetes, known as insulin-dependent, entails permanent unfitness for flying duties in *all* the regulations. The French add that such cases should first of all receive appropriate investigation in a specialised unit of a hospital.

Type I diabetes, known as insulin-independent, is also incompatible with fitness in *all* the regulations except those of *France* and the *UK*.

The French regulations state, in fact, that type I, or "insulin-independent" diabetes may be compatible with fitness following a *prior period of observation* in a specialised unit, which alone is qualified to make an assessment, whenever the use of oral synthetic hypoglycaemic medication is found to be necessary. However, the use of oral antidiabetic medications, involving the possibility of hypoglycaemic accidents (sulphonyl-ureas causing hypoglycaemia) is incompatible with flying, but the use of biguanides, not leading to hypoglycaemia, is compatible with flying. In such cases, the subject must be awarded the Class 2 general standard of medical fitness only, that is, he is no longer permitted to act as pilot of a jet fighter, reconnaissance or bomber aircraft, nor as navigator, bomb-aimer or radar operator.

However, if the glucose metabolic disorders (alimentary or intermittent glycosuria, paradiabetic conditions) have shown that they are reversible, either after further tests, or after a period under observation in a hospital, or after following an appropriate diet, they are regarded as compatible with the retention of a standard of fitness for full flying duties (Class 1 medical fitness standard).

The UK regulations have similar provisions and state that in the case of serving personnel a *mild* degree of diabetes mellitus controlled by diet or hypoglycaemic therapy is compatible with an assessment of fitness for flying duties. Each case must, however, be examined thoroughly in a specialised unit before a decision is taken. These provisions relating to insulin-independent diabetes are to some degree similar to those made for the same type of case in the French regulations.

C. CONCLUSIONS

The main tenets expressed in the regulations in regard to the initial examination show almost complete similarity of views.

With regard to serving personnel, there are two disorders to which this similarity of thought does not apply: hyperthyroidism and diabetes mellitus.

In regard to *hyperthyroidism*, the fate of subjects who have been treated surgically or by radioactive isotopes is a point on which one would be entitled to ask for the expression of a clear opinion, as a helpful supplementary directive, in the majority of the regulations.

On the subject of *diabetes*, the importance to be attributed to a family history would seem to merit some revision in the light of the most recent epidemiological knowledge. However, insulin-independent diabetes should primarily direct the attention of the authorities. The French regulations are clear in regard to the fitness of aircrew who use only oral hypoglycaemic medication. It would appear that recent advances in this type of therapy mean that we can no longer evade the question of the insertion of precise texts in other regulations so that the examining medical officers are given a uniform statement on the line of action to be taken.

CHAPTER VIII

NEUROLOGICAL AND PSYCHIATRIC DISORDERS

All the regulations make a clear distinction between aspects which come under the heading of neurology and those which belong to the field of psychiatry, although in practice the neurological and the psychiatric examinations sometimes present aspects which are difficult or impossible to dissociate during the assessment examination.

A. INITIAL EXAMINATION

I Neurological Examination

(a) Anatomical and functional soundness of the nervous system is required.

(b) *An electroencephalogram* is recorded as a matter of routine at the initial selection examination or before the start of flying training (Canada). This is now a general rule even though it does not yet appear in the text of some of the regulations for the assessment of fitness. Separate instructions requiring its use are issued by those countries concerned, and contain guidelines for interpretation of the traces. One basic principle is now well established in all the Air Forces.

A normal standard trace, showing an alpha activity in 9 or 10 c/s with a symmetric occipito-parietal localisation, excluding other rhythms, is only met in 40 to 60 per cent of the examined pilots and is dependent on their age. Therefore, the concept of *normality* must be very extensive and too rigid standards must be avoided. Nevertheless, individuals without any pathological history and who are clinically healthy at the time of the examination, present traces which are very different from the defined normality. The French technical notice concerning electroencephalographic examinations comments that "in a group of young individuals, the causal factor is not usually an ignored or unrecognized neurological disease, but is more often functional disturbances, partly related to physiological conditions (fast, fatigue, lack of sleep) or to psychological situations (mental stress, anxiety) at the moment of the examination, and partly related to immaturity or to a neurotic personality. Therefore, no decision of unfitness should be taken upon presentation of a trace, without taking account of the clinical context".

Another principle is generally accepted: the electroencephalogram recorded at the initial selection examination finds its main justification as a reference trace for comparison with traces obtained after a head injury or in some pathological states occurring during the service career.

The conclusions of an electroencephalographic examination must be different in the case of an initial examination and in the case of a periodic examination. The French technical notice which has been mentioned above, lays down the following rules, applicable at the *initial examination*.

(a) *Are presently unfit:*

- individuals presenting spontaneous or provoked paroxysmic electrical episodes evocative of epilepsy or, at least, of an important epileptogenous potentiality. A trace, obtained under provoked sleep, which very often stimulates the paroxysmic discharges, can help the expert in his decision.
- individuals who, after a head injury, present centres of theta or delta slow waves or old irritative localisations as sequelae of their head trauma.
- individuals presenting important functional abnormalities, if these signify the possibility of an underlying mental pathology, incompatible with fitness (to be confirmed by the consultant psychiatrist) or if they arouse clinical manifestations before, during or after the recording of the trace (vagal syncope, tetaniform crisis, exaggerated emotional behaviour).
- obvious focalised or generalised abnormalities leading to the possibility of a diagnosis of cerebral lesion having a non-traumatic origin.
- major and constant vigilance disturbances.

(b) *Are temporarily unfit:*

- individuals presenting moderate electroencephalographic sequelae of a trauma or a cerebro-meningeal illness, if these sequelae are considered as liable to improvement in the future.
- individuals presenting major functional abnormalities related to an identified temporary cause: fast, fatigue, lack of sleep, absorption of drugs, etc.

— too young or immature individuals whose EEG has a chance of normalisation or stabilisation in the future.

(c) *Are temporarily fit:*

- individuals presenting moderate abnormalities which are sequelae of previous illness or functional abnormalities which are under control; these individuals are liable to be declared fit, subject to a half-yearly or a yearly check.
- in some cases, with a normal EEG, the fitness can be limited, even at the initial examination, by reason of accidents or clinical manifestations which have occurred before admission and which necessitate safety checks during a prolonged period (maximum: 2 years).

(d) *Are fit without limitation:*

- individuals who are inside the limits of the electroencephalographic normality, considered in the least restrictive meaning.

Note

In the present state of knowledge, the results of the electroencephalographic examination are not taken into account for allotment of standards SGA1 and SGA2. Candidates are declared "fit" or "unfit" and only in the latter case, is the standard SGA/0 allotted to them. As an exception to this rule, candidates presenting a hypersensitivity to intermittent luminous stimulation can be declared fit, except for piloting helicopters, by reason of the stroboscopic effects of the blades of the helicopter rotors.

(c) *Neurological Pathology and Flying Duties*

The importance of neurological pathology is recognised in all the regulations which give a more or less detailed list of the diseases, groups of diseases, past history and sequelae of illnesses or of accidents which are disqualifying for flying duties. These lists show wide agreement. Mention will be restricted to a few points of special importance, either because they provide extra details, or, in some instances, express divergent views which arouse interest and deserve some consideration.

1. *Craniocerebral trauma*

In this connection, the regulations can be divided into three groups:

- (1) the French and the Belgian regulations;
- (2) the UK and the Canadian regulations;
- (3) the American, German and the Norwegian regulations, the latter being similar in all points to those of the USAF.

(1) *The French and the Belgian regulations* are basically practically similar. Furthermore, their essential points are found in all the other regulations, although stated less precisely or less comprehensively in the UK and the Canadian regulations, and — at the other extreme — in much greater detail in the American regulations, the Norwegian regulations and the German regulations.

The following is the text of the French regulations.

Reasons for rejection:

- (a) loss of cranial substance, congenital or post-traumatic;
- (b) a history of open head injury;
- (c) any history of closed head injury, except in cases where an initial benign injury — assessed in particular on the duration of the loss of consciousness — is confirmed by the absence of clinical, radiological, electroencephalographic, ophthalmological or otorhinolaryngological sequelae, and providing it occurred more than one year previously.

(2) *The UK and Canadian regulations* express these basic principles in a more concise manner but do not stipulate any minimum period which should elapse between the injury and the medical fitness examination.

(3) *The American regulations* give a great wealth of detail about the types of injuries which entail rejection, although such injuries are, in fact, reduced to the three types quoted in the French and the Belgian regulations. One of their characteristic features should be noted: they attribute a great deal of importance to the period of loss of consciousness following cerebral concussion. For this one factor (duration of unconsciousness), three different situations are considered: these will considerably influence the decision to award an assessment of unfitness or the minimum period which should elapse between the accident and the medical fitness examination in order that an assessment can be made.

If the period of unconsciousness is more than 1 hour, the candidate is assessed as unfit. In the case of shorter periods, according to whether the period of unconsciousness is between one hour and 15 minutes, or is less than 15 minutes, the minimum time to elapse between the accident and the medical examination is respectively two years and six months, and acceptance for flying duties will be authorised only if a complete neurological examination reveals no further abnormalities.

The following text, taken from the USAF regulations, is quoted as a reference text. The texts of the US Army regulations and the US Navy regulations, although not identical, have however many similarities.

"A history of head injury resulting in any of the following is a cause for rejection:

- (a) intracranial haemorrhage (epidural, subdural or intracerebral) or subarachnoid haemorrhage;
- (b) penetrating injuries of the brain;
- (c) any skull fracture, linear or depressed, with or without dural penetration;
- (d) radiographic evidence of retained metallic or bony fragments;
- (e) transient or persistent neurological deficits indicative of parenchymal central nervous system injury, such as hemiparesis. Damage to one or more cranial nerves is not necessarily disqualifying unless it interferes with normal function in some practical manner;
- (f) cerebro-spinal fluid rhinorrhea or otorrhea;
- (g) any post-traumatic syndrome, as manifested by changes in personality, deterioration of higher intellectual functions, anxiety, headaches or disturbances of equilibrium;
- (h) unconsciousness for more than 1 hour;
- (i) unconsciousness for more than 15 minutes, but less than 1 hour, unless *two years* have elapsed since the injury and a complete neurological evaluation is normal in all respects;
- (j) unconsciousness for less than 15 minutes, unless *six months* have elapsed since the injury and a complete neurological evaluation is normal in all respects."

It should be pointed out that the US Navy stipulates rejection in the case of head injury resulting in unconsciousness for more than 24 hours, or followed by post-traumatic amnesia, or an impairment of judgement for more than 48 hours.

In the US Army regulations, as also in the French and the Belgian, any individual who has been unconscious or has suffered from amnesia for more than 15 minutes following concussion cannot be accepted for flying duties within a year of the injury and must undergo a detailed neurological examination to establish the absence of any anomalies.

Head injury with the following sequelae or characteristics entails the rejection of the candidate:

- (a) unconsciousness lasting for more than two hours;
- (b) amnesia lasting for more than two hours;
- (c) change in personality or deterioration of intellectual faculties;
- (d) craniotomy;
- (e) depressed fracture or loss of bony substance of the skull;
- (f) focal neurological signs (paralysis, paresis, disturbance of sensation, convulsive seizure);
- (g) post-traumatic headaches persisting for three months after the accident.

Subjects with head injuries not associated with any of the above complications are not necessarily acceptable. The decision is based on factors such as the duration of the initial period of unconsciousness, the importance of the immediate clinical syndrome, and the delayed sequelae as assessed from clinical, radiological, electroencephalographic and psychiatric findings.

(4) *The Norwegian regulations* are similar to the USAF regulations.

(5) *The German regulations* can be summarized as follows:

- (a) Permanent unfitness for flying duties in case of cerebral injury caused by an open cranial trauma or by a closed cranial trauma, if this cerebral injury is evidenced by an EEG.
- (b) Temporary unfitness for flying duties, in any other case of closed cranial trauma.
 - In case of a simple cerebral concussion, the duration of unfitness is at least one month from the day of the trauma.
 - In case of a severe cerebral concussion resulting in amnesia lasting for more than one hour for the period following the accident (retrograde amnesia) or an amnesia for the period preceding the accident (anterograde amnesia), the duration of unfitness is at least three months.
 - In case of a cerebral contusion, the duration of unfitness is at least six months.

2. A history of primary encephalitis of viral origin, or a history of secondary encephalitis following infectious diseases is evaluated in relation to its initial severity or its duration. The same applies to meningismus, muscular atrophy and polyneuritis. When these diseases have left no signs or when the examination shows only very slight sequelae which would not affect the performance of flying duties or flight safety, they are compatible with fitness.

The subject on which there are profound differences of opinion from one set of regulations to another – whenever it is in fact mentioned – is the minimum period required to elapse between the onset of the disease and the medical fitness examination. Although such numerical data are necessarily of an arbitrary character, it must be recognised that they sometimes differ greatly in the case of the same disease.

3. *Isolated episode of loss of consciousness – Syncopal states*

In all the regulations a history of epilepsy, in any of its clinical forms – fits of absence (*petit mal*), dizziness, auras, ideomotor automatism, temporal epilepsy – entail rejection.

A history of unexplained fainting is a cause for rejection in all the regulations. Some of them, however, refer to this as lipothymic states or vasomotor lability states.

II. Examination of Mental Capacity and Emotional Stability

In all the Air Forces covered in this study, the candidate's mental capacity and emotional stability are investigated first of all during the general medical examination.

The neurological and personality findings thus obtained are supplemented as necessary by a neuropsychiatric or psychological examination performed by a doctor, specialist in neuropsychiatry or in clinical psychology.

Finally, this completely medical examination is quite often supplemented by group psychology tests. The results of these tests are not, however, taken into account in the assessment of the actual medical examination. These tests, moreover, are carried out and evaluated by a Board, the majority or all of whose members are not medical specialists. This selection Board is not a medical body and therefore this form of investigation of the personality of a candidate, as conducted by the group psychology method, is not regarded as an integral part of the medical fitness requirements. The methods adopted lack conformity and are not easily codifiable. The UK regulations state clearly in their comments that there are no group tests which can provide a valid analysis of character or personality and that the medical officer must rely on careful history taking.

With regard to the *medical* examination of mental capacity and emotional stability, the various regulations have the same characteristics as those already noted on the subject of craniocerebral injury.

1. *The regulations for France, West Germany, and Belgium* do not give an exhaustive list of diseases which are reasons for rejection, but indicate groups of diseases falling within this category. Details of a practical nature are added to these lists, or help to clarify them, or in some cases they refer to specific diseases or anomalies.
2. *The UK, and Canadian regulations* are very concise and sparing of detail. Such details as are given appear rather in the nature of guidelines.
3. *The regulations for the American services* provide very full lists of diseases and anomalies which entail rejection. *The Norwegian requirements* are similar to those of the USAF.

An extremely original aspect is presented in the *French regulations* in the sense that the sub-chapter devoted to the psychiatric examination draws attention to the results which can be expected in the three successive phases of the examination of the candidate, two of which are included in the general examination, and the third is, in fact, an examination by a specialist. For each of these three phases, mention is made of the various conditions which are reasons for rejection or which constitute warning signs. These gradual steps in the conduct of the investigation are of very great assistance to the medical examiner in his work on this difficult and delicate aspect of the selection process, in which marginal states are more frequently found than well established pathological conditions. After a diagnosis has been made, the American regulations obviously make it easier for the medical officer to arrive at a decision by presenting him, in the form of an official text, with precise reason for rejection under the heading of a diagnosis.

The ideal solution would appear to be a combination of the French and the American approaches to the problem.

For reference purposes the text of the French regulations is quoted in full below.

"Mental capacity and emotional stability (psychiatric examination)

The general medical examination should attempt to elicit certain past history and to detect a number of clinical warning signs.

(a) *Investigation of past history*

Past history should be carefully investigated, after gradually obtaining the confidence of the subject; no standardised form of questioning should be used.

The examination should check systematically for evidence of any of the following points:

(1) Certain past history which is immediately disqualifying:

- personal psychopathic history: mania, melancholia, delirious outbursts, mental confusion, schizophrenic states, neuroses (hysteria, obsessional neurosis, anxiety neurosis), perversions, repeated depressive reactions.

Any subject who has undergone therapy in a psychiatric department or in a psychiatric hospital is disqualified.

(2) Certain past history justifying psychiatric examination by a specialist:

- family psychopathic history;
- enuresis at a late age, transient somnambulism, nightmares, neuropathic crises or reactions, repeated fainting or syncope of uncertain aetiology, motion sickness, repeated migraines, stammering instability (motor, emotional or professional) associated with impulsive reactions, medico-legal reactions, juvenile delinquency, attempted suicide.

(b) *Neurological and personality findings of the general medical examination*

The general medical examination provides an opportunity for observations of a candidate's mental capacity, both on the intellectual level and the emotional stability level, and of his general behaviour and demeanour. When the observations have been completed - if necessary - by the various specialist medical officers at the Medical Establishment, they must be communicated to the general medical examiner who must try to compile an overall report and, as necessary, refer the candidate to a psychologist or a neuropsychiatrist.

The following are regarded as clinical danger signals:

- peculiarities in attitude or behaviour;
- excessive and repeated awkwardness, signs of motor debility, slowness of intellect;
- exaggerated emotivity as manifested by a behaviour disorder, inappropriateness of the replies to questions asked, confusion under examination conditions revealing itself either in anxious sub-agitation, or excessive timidity.

Special attention should be paid to vasomotor instability, to the extent to which this reflects emotional instability: tremor, blushing, excessive paleness - whether continual or transient, - pronounced sweating, proneness to syncope, disturbed cardiac rhythm (extrasystole, sinus tachycardia which does not decrease during the examination) - increase in blood pressure of emotional origin.

These factors should be compared with the other clinical factors as a basis for a decision by the examiner whether to declare the candidate unfit straightaway, or to refer him for examination by a specialist.

(c) *Examination by specialist*

The neuropsychiatric examination performed by a specialist should attempt to arrive at a very precise statement of the mental capacity of the candidate, supplemented as necessary by the results of personality tests. Although it would not be appropriate to specify any single type of character structure denoting fitness for aircrew duties, it should be emphasised that harmony of personality is desirable, and that emotional stability must be satisfactory; the need for absence of any major neurotic conflicts or psychosomatic diseases or reactions should also be stressed. Subjects with undisputed psychopathic personalities and those who are seriously unstable should be rejected.

Emphasis is placed on an assessment of professional motivation, it being understood, however, that certain subjects whose motivation is neurotic in character may find in aviation a method of stabilising their personality in a satisfying professional activity.

The examiner must take into account that the role of any aircrew member is one of individual responsibility, assumed while working with others, and that any candidate must be able to adapt to his social environment and work efficiently as a member of a group.

The examiner must reach a conclusion:

- either to declare the subject unfit;
- or to declare him fit without any reservations;
- or to declare him fit, but with the qualification: "to be supervised during training from the point of view of adjustment".

B. PERIODIC EXAMINATION

I. Neurological Examination

(a) *A routine electroencephalographic examination* during periodic examinations is required only in the French regulations. It must be performed every five years on all pilots and navigators/bomb aimers in every case, irrespective of the past history of the persons concerned. No other regulations contain this requirement. They all, however, stipulate that an electroencephalogram should be recorded during checks for sequelae of head injury, at the time of the periodic examinations carried out at fixed intervals, for a specified period, following the injury (see below), or when disturbances of cerebral function are suspected.

With regard to the decisions of the experts, the problem is more simple than at the initial examination.

The French technical notice concerning the electroencephalographic examinations gives the following rules:

"If it is well known that the subject has only minor abnormalities, detected at the initial examination, a supervision of their evolution — very frequently favourable — on the occasion of a half-yearly or yearly EEG during a reasonable period of time is sufficient.

If the abnormalities appear during the career, the usual neurological, radiological and clinical investigations must be carried out, as the problem is not only related to fitness, but also to medical treatment. The decision of the experts essentially depends on the results of these investigations and the discovery of a neurological impairment is, usually, a cause of unfitness.

Isolated abnormalities of the EEG, associated with normality in the other investigations and without severe clinical picture entail a temporary unfitness or a temporary fitness for several months. In such circumstances, the supplementary observation period is often necessary before a final decision.

As a matter of fact, an electrical trace is not, by itself, a cause of unfitness, except when discharges of typical epileptic spike-waves are present. The true reason of unfitness is an electro-clinical picture suggesting an evolving disease, severe sequelae of an earlier illness or, at the initial examination of a young candidate, a more complete picture of a biological and psychological immaturity, a presage of future difficulties."

- (b) *A neurological examination* is conducted at the time of all the periodic examinations.

Speaking generally, and without entering into the wealth of detail found in some of the regulations, the commonly held view can be summarised by saying that:

- (1) organic diseases of the nervous system entail permanent or temporary suspension of flying, depending on their degree of curability or development;
- (2) for an assessment of fitness, neurological diseases which have occurred between two periodic examinations must have lost all signs of activity;
- (3) any form of epileptic fit (grand mal, petit mal, focal epilepsy etc.) entails rejection.

- (c) The following *special points* deserve particular attention.

- (1) *Electroencephalographic abnormalities* in otherwise apparently healthy individuals carry the following comments in the USAF regulations: "These abnormalities are not necessarily disqualifying, with the exception of spike wave complexes and focal spikes."

This point of view is accepted by the medical services in the other Air Forces, even though this rule is not always expressed so clearly. (See (a) above.)

- (2) *Fainting*

Interpretation of syncopal states in aircrew members obviously requires very careful consideration.

All the regulations list syncope or syncopal states among the causes of unfitness for flying duties. This is undoubtedly an immediate but temporary measure until such time as the cause of such a condition has been clarified. It is this cause which determines whether the candidate is to be permanently or temporarily unfit.

An indication of the care to be exercised by the medical examiners in this field is reflected in a Note under the heading "Fainting" in the USAF regulations, the content of which is as follows:

" Syncope due to pain following severe injury, or during convalescence from an acute infection or severe loss of blood will be referred through routine channels to HQ USAF for waiver after appropriate consultations have been obtained. Fainting in rated personnel due to any other cause will be considered for waiver by HQ USAF only after complete evaluation by an Aerospace Medicine Consultation Service. All cases of syncope in rated or designated flying personnel will be reviewed by HQ USAF with the exception of flying training students already evaluated by the Surgeon, Air Force Academy, Air Training or Air University."

- (3) *Decompression sickness* with neurological symptomatology entails the rejection of flying personnel.

This reference to a serious form of decompression sickness appears in an explicit manner only in the USAF regulations. Such a reference would, however, be fully justified in the other regulations and would have the advantage of removing any doubt in the minds of medical officers when confronted with the case of aircrew who have suffered such an incident.

- (4) *Head injuries*

The action to be taken in regard to airmen involved in accidents in which they suffered head injuries is covered by precise and detailed instructions. The guiding principles contained in all the regulations present great similarity. Nevertheless differences do appear in regard to the nature of the complications which are causes for permanent or temporary unfitness and on the minimum period of temporary unfitness, before any other decision is taken, whenever certain signs or symptoms have been noted following the accident. The most detailed, precise and explicit requirements in the directives issued are those of the USAF, which will be described first of all, as a basis for subsequent comparison with the standards laid down in the other regulations.

(a) *USAF regulations*

The rules to be followed by medical officers stipulate very clearly the conditions requiring an assessment of permanent unfitness or of temporary unfitness. The minimum period for this temporary unfitness is fixed at two years, three months or four weeks, according to whether certain symptoms are present or not; it remains unspecified in some circumstances where it is difficult to predict the further development of the case.

1. The following are causes of permanent unfitness:

- (a) craniotomy and any loss of bony substance of the skull;
- (b) head injury with any one of the following complications:
 - i. period of unconsciousness exceeding 24 hours;
 - ii. depressed fracture, with or without dural penetration;
 - iii. laceration or contusion of the brain, or penetrating brain damage;
 - iv. epidural, subdural or intracerebral haematoma;
 - v. post-traumatic infection of the central nervous system (abscess, meningitis);
 - vi. cerebro-spinal fluid rhinorrhea or otorrhea, persisting more than 7 days;
 - vii. generalized or focal convulsions;
 - viii. transient or persistent neurological deficits indicative of parenchymal central nervous system injury (hemiparesis, hemianopsia);
 - ix. evidence of permanent impairment of the higher intellectual functions or alteration of personality as a result of injury;
 - x. persistent, focal or diffuse abnormalities of the electroencephalogram, reasonably assumed to be the direct result of injury.

2. Head injury associated with any one of the following complications will be a *cause of temporary unfitness for at least two years*:

- (a) unconsciousness for a period of more than 2 hours, but less than 24 hours, with or without linear skull fracture (basilar fracture is considered a linear skull fracture);
- (b) post-traumatic amnesia (partial or complete), delirium, disorientation or impairment of judgment or intellect for a period exceeding 48 hours;
- (c) post-traumatic syndrome as manifested by changes in personality, deterioration of a higher intellectual function, anxiety, headaches, disturbances of equilibrium if this syndrome disappears within one month of the injury.

An assessment of fitness for flying duty after this *minimum* period of two years will be granted only if the condition of the subject is completely normal again, as determined on the basis of a neurological evaluation, including in particular skull X-rays, an electroencephalogram and psychometric tests. The electroencephalographic record will include traces obtained as soon as possible after the injury, and then at 6, 12 and 18 months after the injury. The final evaluation, 24 months after the injury, will be carried out at the USAF School of Aerospace Medicine.

3. Head injury associated with any of the following complications will be a *cause of temporary unfitness for at least three months*:

- (a) linear fracture of the skull, without loss of consciousness or with loss of consciousness for a maximum of 15 minutes;
- (b) loss of consciousness for more than 15 minutes, but less than two hours, or post-traumatic amnesia, delirium or confusion for a period less than 48 hours, with or without linear skull fracture (basilar fracture is considered as a linear skull fracture. This diagnosis need not be confirmed by X-rays, but can be based on clinical findings.);
- (c) cerebral spinal fluid rhinorrhea or otorrhea, which ceases within 7 days of the injury, and is not associated with signs of lesion of a cranial nerve.

The examination must be carried out by a qualified neurologist or neurosurgeon at a regional consultation centre, immediately before consideration of the possibility of re-acceptance for flying duties. The electroencephalographic record will include a trace obtained as soon after the injury as possible, and another at the time of the examination, that is, three months after the injury.

If any abnormalities are found at any of the stages of the examination (neurological examination, skull X-ray, electroencephalogram, psychometric tests) the subject will not be declared fit for flying duties and will be referred back to the consultant at three-monthly intervals for re-assessment until he is found fit for such duties.

4. *Temporary unfitness for a period of at least 4 weeks* is required in the case of head injury, *without* skull fracture, which results in unconsciousness for less than 15 minutes, or post-traumatic amnesia, delirium or confusion for less than 12 hours.

An assessment of fitness for flying duties will be given only if the neurological examination at the end of the four week period of disqualification has given normal results.

The neurological examination must include in particular X-rays of the skull, an electroencephalogram and an orthostatic tolerance test.

5. *Temporary unfitness for an unspecified period* is required in the case of head injury resulting in permanent deficit of a cranial nerve, or confusion for a period exceeding 48 hours. A return to flying duties can be permitted only after a complete examination at an Aerospace Medicine Consultation Service, after a reasonable time has elapsed, and only providing this examination results in a recommendation for a return to flying duties.

(b) *The other regulations*

They have one point in common with the USAF regulations: craniotomy and loss of skull substance are disqualifying. With regard to an assessment of the other sequelae of cranial injury, they allow the examiner a greater degree of freedom. They do, it is true, assume the same types of criteria on which to base an assessment (duration of loss of consciousness, amnesia, electroencephalographic abnormalities etc.) and routine safety measures as reflected in the minimum periods for the temporary unfitness of subjects.

However, the subdivision of cases into categories, involving such and such a type of decision, is not found within such precise limits as in the USAF regulations, although the French, Belgian and German regulations are in perfect agreement on one point. In the case of a simple closed head injury, which is slight and does not result in loss of consciousness, if the neurological, electroencephalographic, radiological, ophthalmological, otorhinolaryngological and psychological examinations are negative, the subject can be re-assessed as fit *three months* after the accident.

Apart from these straightforward cases, there are distinct differences.

1. Under the *French regulations* any *open* head injury disqualifies a person for services as a *pilot*. A *closed* head injury, causing a characterised loss of consciousness or coma, entails a period of temporary unfitness which must not be less than *four months* from the date of injury. Where the USAF regulations are based on the *length of the initial period of unconsciousness and on the duration of sequelae which develop later*, in order to create several different categories of temporary unfitness, the French regulations prefer not to lay down any other mandatory limitation except a *four month minimum period of temporary unfitness*. The considerable margin of freedom allowed to the medical examiner when arriving at an assessment is evident from the following text: "Any sequelae of injury should be assessed in relation to the duration of the initial loss of consciousness, the significance of the immediate clinical syndrome and the time which has elapsed since the injury."

Sequelae which develop later (amnesia, effect on personality, neuroses) should be evaluated after clinical, radiological, electroencephalographic, ophthalmological, otorhinolaryngological and psychological findings have been obtained.

An assessment of fitness should, however, be limited to periods of *six months* during the two years following the injury.

An electroencephalographic examination must form a routine part of every periodic examination, that is, every six months, during this period. Such checks can be extended for a longer period if clinical or electroencephalographic factors so require."

2. *The Belgian regulations* state that if sequelae have been resorbed within *12 months* of the injury, the subject may be declared fit, with or without limitations, at the end of an additional period of *six months* during which the results of the examination have remained normal.

This provision applies to cases of mild concussion, with or without fracture of the skull, in which the period of unconsciousness did not exceed three hours.

All other cases, associated with more severe symptoms or sequelae, are causes for permanent unfitness.

3. *The German regulations*, like the Belgian, lay down fairly simple rules.

An open head injury is cause for permanent unfitness.

In cases of closed head injury, the length of the period of temporary unfitness is governed by the degree of concussion.

- Slight concussion, not associated with any neurological abnormality, involves temporary unfitness for a minimum period of one month, from the day of the trauma.
- Severe concussion with an anterograde amnesia for more than one hour, or a retrograde amnesia, involves temporary unfitness for a minimum period of three months.
- Contusion of the cerebral tissues entails unfitness for a minimum period of six months.

Before the resumption of flying duties, the absence of neurological, electroencephalographic and psychological abnormalities must be demonstrated. During the first six months of flying activities, flying is only authorised in aircraft having dual controls and with the presence of another pilot on board. Before arriving at a decision of fitness without any restriction, a psychological examination is necessary.

After any cranio-cerebral trauma, a neurological examination and an EEG examination must be performed as soon as possible.

The medical examination for fitness after a cranio-cerebral trauma must be carried out at the Institute of Aviation Medicine; it must include a special psychological examination.

4. *The UK regulations* are quite the opposite of those for the USAF, and their brevity lends an air of vagueness to the directive formulated. It is clear that they are meant to allow maximum freedom of decision to the specialist medical officer. Skull fracture need not necessarily entail permanent unfitness unless there has been intracranial damage, or unless a depressed fracture has occurred, or there is a loss of bony substance.

In cases of less severe head injuries the standards on which an assessment of fitness for flying duties is based will be the absence, or the degree of severity, of any neurological, electroencephalographic or psychiatric sequelae.

5. *The Canadian regulations* are extremely concise. Sequelae of head injury indicating permanent brain damage are causes for unfitness.

6. *The US Army regulations* are less strict than those of the USAF in regard to serving personnel.

Injuries are assessed by the same standards as those which involve rejection of *candidates* for flying duties in the US Army, although initially they require only a temporary period of unfitness of at least *one year*. A final assessment of unfitness will depend on the occurrence of persistent and severe sequelae.

A craniotomy for whatever reason must entail a period of temporary suspension for at least one year, followed by a final assessment of unfitness if *convulsions, complications or other serious sequelae* appear.

7. *The US Navy regulations* are also much more concise than those of the USAF and are restricted to a few general principles.

A period of three months' temporary unfitness must elapse before the medical fitness examination following cerebral concussion resulting only in apparently temporary abnormalities.

Depressed fractures in the vicinity of the central interhemispherical groove, with or without convulsions, entail rejection.

Head injuries associated with a period of unconsciousness of more than 24 hours, or followed by post-traumatic amnesia or an impairment of judgment lasting for more than 48 hours, are a cause for permanent unfitness.

For shorter periods of unconsciousness the criterion is exactly the same as for the USAF.

In the case of amnesia or impairment of intellectual functions the US Navy requires first of all a period of temporary unfitness for two years. It appears probable, however, that apart from these guidelines the examiner's decision will be governed by the results of examinations by specialists.

8. *The Norwegian regulations* are identical to those of the USAF.

II. Examination of Mental Capacity and Emotional Stability

All the regulations stipulate the rejection of subjects suffering from psychoses or active psychopathic episodes. In practice, however, the most numerous and the most difficult cases are primarily the individuals suffering from anxiety or presenting personality anomalies. When likely to endanger flight safety, and taking into account the seriousness, the form or the prognosis of their disorder, they are removed either permanently or temporarily from flight duties.

These are the general principles.

Some special features found in a few of the regulations deserve particular mention.

1. In such a difficult matter as this, the *French* regulations provide a very precise guidance for the medical examiner.

The full text of the regulations relating to the psychiatric examination of serving personnel is therefore reproduced below:

"The psychiatric examination shall be carried out by a *specialist* whenever the subject has suffered from a particular disorder since the last periodic examination. The specialist shall also be consulted if the observations of the command authorities or of the unit medical officer so require.

The general medical examination can provide an opportunity of assessing the general behaviour of the subject, whose demeanour will be indicative of his mental and emotional state, and of the possible advantage of a more detailed assessment by a specialist.

Depressive or anxiety syndromes are a cause for temporary unfitness; they shall be assessed in relation to the predisposition of the subject, to his particular condition from the psychological point of view and to the difficulties objectively encountered during flying activities.

Air sickness in psychopathic personalities is a cause for unfitness.

Post-traumatic neuroses shall be assessed according to the personality structure and the extent of the emotional trauma. In this connection, as on the occasion of all periodic examinations, the specialist examiner shall aim less at the systematic unfitness of personnel than at their possible rehabilitation. The examiner must remember that his attitude during the examination and particularly the way in which he informs the subject of his conclusions may considerably affect the development of the disease involved, and also the results of therapeutic treatment.

As a general rule and bearing in mind the need for complying with the regulations on flight safety, a provisional assessment of fitness at a lower standard is psychologically preferable to a prolonged period of unfitness for employment on any flying duties."

Concerning individuals whose flying function only requires the general standard of fitness No.2, namely duties other than fighter pilot, reconnaissance pilot, bomber pilot, navigator-bomber-radar (see Annex 1), moderate reactional psychological disorders and some symptoms of partial loss of professional adaptation are compatible with fitness but with limitations and modifications of flying activities. Fitness is only granted after a favourable opinion from the specialist and after chemotherapy has completely stopped.

2. *The German regulations* are interestingly precise in this field.

Psychological examinations are not generally included in the normal scheme of periodic examinations or of episodic examinations. They are carried out at the request of medical authorities, particularly of the Director of the Institute of Aviation Medicine, in the following cases:

- (1) after aircraft accidents or incidents, when the causal role of psychological or psycho-physiological factors is suspected or when some doubts exist on the explanations given of the event by the individual concerned;
- (2) in cases of considerable reduction of flying performance (e.g. a diminution of efficiency due to age);
- (3) in cases of anxiety caused by flying activities and in cases of loss of motivation regarding flying duties;
- (4) in cases of persistent airsickness, of psychosomatic disorders, of abnormal behaviour or of special situations of social conflict;
- (5) after cranio-cerebral traumas;
- (6) when the subject brings in question the piloting or the maintenance of aircraft;
- (7) before any proposal for appointment as pilot of jet transport aircraft.

The essential bases of this special psychological examination are listed below:

- (1) aptitude and dexterity tests simulating real conditions,
- (2) controlled observation of the behaviour and performance in stress conditions,
- (3) exploration of the motivation for flying by use of interviews and standardised questionnaires,
- (4) longitudinal analysis of the aeronautical career; study of the opinion expressed by the subject's superiors on flying activities and more especially on causes of accidents.

The conclusions of this clinical psychological examination are therefore based on:

- (1) mental and psycho-motor aptitudes and performances,
- (2) psychodynamics, emotional stability, rational and voluntary behaviour, especially in stress conditions,
- (3) neurotic, psycho-vegetative symptomatology and its origin,
- (4) psychological and mental conditions met in accidents and their sequelae.

The German regulations are rather concise in regard to the list of diseases and disorders entailing a temporary unfitness: temporary nervous exhaustion, depressive reactions and abnormal behavioural traits.

Well established forms of neurasthenia, neuropathy and psychopathy, serious neuroses and endogenous psychoses, even if they have been successfully treated, entail rejection.

3. *The Belgian regulations* are confined to the general principles quoted above in regard to psychoses, psychoneuroses, anxiety states and personality disorders.

4. *The UK regulations* are confined to general directives for the examiner but do not lay down any hard and fast rules.

5. Following their usual method the *American regulations* give a detailed list of the disorders and abnormalities on the psychiatric level which are causes for rejection.

The *USAF regulations* state clearly that character and behaviour disorders, including drug abuse, which are incompatible with flying, and fear of flying in serving personnel are causes for *administrative* suspension and not for disqualification on medical grounds.

On this particular point the *US Army regulations* seem to differ. The following are in fact listed, without further comment, among the causes for *medical* disqualification:

- (1) abnormal emotional responses to situations of stress (in combat conditions or otherwise) when, in the opinion of the examiner, such reaction interferes with the efficient and safe performance of an individual's flying duties;

- (2) excessive use of alcohol or drugs, which has interfered with the performance of duty;
- (3) fear of flying, when this is a manifestation of a psychiatric illness. On the other hand, refusal to fly or fear of flying, not due to a psychiatric illness, is an administrative problem and not a cause for disqualification on medical grounds.

After explaining the methods to be used for conducting a psychiatric examination of aircrew, the *US Navy regulations* do not discuss explicitly this question of the allocation of the respective responsibilities of the medical branch or of the executive authorities in regard to fear of flying and refusal to fly. This is probably dealt with in special directives which do not necessarily belong to regulations concerned with medical fitness.

6. The *Canadian regulations* follow the general lines of the USAF. Military aircrew suffering from a definite *psychosis* are rejected on medical grounds.

Those suffering from a *neurosis* associated with *anxiety* or somatic manifestations which make them incapable, in practice, of performing their duties must be rejected on medical grounds.

Aircrew suffering from a *neurosis* but who are otherwise fit to perform their duties are not rejected on medical grounds.

The same rule applies to character disorders, maladjustment or emotional immaturity to a degree sufficient to render them unfit for service.

If the medical and the administrative authorities jointly consider it desirable that such airmen should be rejected, this is effected by the *administrative* action laid down for this purpose and not on the basis of medical disqualification.

7. The regulations for the *Norwegian Air Force* are the same as those for the USAF.

C. CONCLUSIONS

The drafting of regulations covering the neurological and psychiatric fields is certainly beset with enormous difficulties. In the face of such problems, two main concepts emerge.

The first one, as represented by the American regulations, and particularly those of the USAF, attempts to detail, as far as possible, the list of diseases constituting causes for temporary or permanent unfitness. For example, for cases of head injury, the minimum periods of temporary unfitness after the injury, prior to a final medical assessment, are fixed quite precisely, depending on certain evidence (duration of unconsciousness, amnesia etc.).

This concept is not free from arbitrariness. Although it does not always satisfy the examiner because of its mandatory character, at least it protects him from criticisms and protects the aircrew member from too strict an assessment not supported by precise regulations. The arbitrary nature of certain actions, particularly in the neurological field, may obviously be a source of divergent views in the various regulations dealing with the same topics. This is clearly observable as a result of a comparative study of the decisions taken on the very same pathological situation.

In the second concept the examiner enjoys a very large degree of freedom when arriving at his judgments, it being fully understood that this decision is based on the whole of the neuro-psychiatric examination. If it is true that each individual case, not only in the field of neurology, but particularly in those of psychology and psychiatry, has its own inherent characteristics, it is no less true that medical decisions must necessarily remain within the framework of a classification based on precedents. It is certainly in order to avoid being accused of too great a lack of precision — which is always a possible source of non uniformity in the decisions taken within a single armed Force — that some of the regulations include quantitative data, in a fairly general text, on the duration of symptoms or the duration of temporary unfitness, for the purpose of facilitating the classification of the various types of decision. In addition, some regulations, principally the French and the German regulations, and, to a lesser degree, those of the UK, expand on certain main points as a guide for the investigations relating to the mental and emotional capacity of the aircrew member, in order to arrive at an irrefragable assessment of his fitness for flying, rather than give a long list of diagnoses signifying temporary or permanent disqualification.

The pros and cons of these two concepts could form the subject of endless discussion. Everything connected with their application is a question of judgment based on common sense and experience of the experts. The two concepts are not irreconcilable and the gap which separates them can be filled in part. The approach adopted by the French, both on the neurological and the psychiatric levels, provides proof of this. A comparison of the medical statistics from the various Air Forces on series of cases of a similar nature would appear to offer a basis for arriving at a concept which would standardize the points of view and decisions expressed in the various regulations.

This field is certainly open for useful confrontation between specialists in the NATO Air Forces.

CHAPTER IX

DETECTION OF ATHEROMA AND METABOLIC DISORDERS WITHOUT CLINICAL SYMPTOMATOLOGY

In all the Air Forces concerned, it is clear that the initial clinical examination and the annual or periodic examinations include not only urine and haematological tests, but also various biochemical tests, although a list of these does not necessarily appear in the text of the regulations.

In connection with the medical examination for flying high-performance aircraft, the *Canadian regulations* stipulate that this examination should include, in particular, a series of biochemical and haematological tests.

The *USAF* publishes, as an Appendix to its Regulation AFM 160-1, a table of the most important normal values for biochemical analyses and tests. This is no doubt because they are relevant to the clinical examination, either in a routine manner for some of these tests, or as the need arises, in the case of other tests.

The *Belgian and the British Regulations* do not specify what they require in this field.

Only the *French regulations* and the *German regulations* contain precise texts which make it *compulsory*, for all candidates and for all flying personnel, to undergo a systematic biological examination.

The *French regulations* require the following blood tests to be carried out:

1. At the initial examinations

- count of the red blood cells,
- count of the white blood cells,
- differential count of the white blood cells,
- haemoglobin concentration,
- erythro-sedimentation rate,
- total lipids in serum,
- total cholesterol in serum,
- triglycerides in serum and lipidogram,
- glycaemia.

Dyslipidaemia is a cause of rejection, not by reason of an immediate incompatibility with flying, but because it means a very great atherogenous risk in the future.

To justify a decision of unfitness, the laboratory results must be confirmed several times and must exceed the following limits:

- total lipids: 9 grams
- total cholesterol: 3 grams
- triglycerides: 2 grams.

2. At the periodic examinations

A systematic biological examination for detecting atheroma and degenerative vascular diseases associated with metabolic disturbances (obesity, gout, diabetes, lithiasis) is compulsory. The biochemical findings should include, as a minimum, the results of the following analyses:

- total lipids in serum,
- total cholesterol in serum,
- triglycerides in serum and lipidogram,
- glycaemia,
- uricaemia.

Before the age of 40, the above tests are compulsory every five years. From the age of 40 on, they are carried out at each yearly examination.

The value of these tests lies in the opportunity to propose an appropriate diet and, in some cases, to prescribe synthetic drugs reducing hypercholesterolaemia. Biochemical disturbances (hypercholesterolaemia, hyperlipaemia) associated with clinical or radiological stigmata of atherosclerosis (e.g. arterial calcification) are a cause for unfitness.

The German regulations require the following tests to be carried out at the initial examination and at each periodic examination:

- count of the red blood cells,
- count of the white blood cells,
- differential count of the white blood cells,
- haemoglobin concentration - detection of haemoglobin "S" and "C",
- hepatic functional tests; serum enzymes (transaminases, gamma-glutamyl-transpeptidase) and bilirubinaemia,
- uricaemia,
- amount of blood lipids: total cholesterol, triglycerides, lipidogram.

At the initial examination, candidates presenting hyperlipoproteinaemia, of types I to V according to Frederikson, are rejected. The same applies to candidates with hyperuricaemia, even if it is still asymptomatic.

At the periodic examinations, the same rules are used. Furthermore, individuals suffering from gout are declared permanently unfit.

Considering the efforts now being made everywhere to detect situations which might lead to cardiac and vascular diseases, it is surprising to find only two sets of regulations containing provisions with no loop-holes, specifying a minimum number of biochemical tests, and condemning certain biological disturbances (hypercholesterolaemia, hyperlipaemia) associated with clinical or radiological stigmata of atherosclerosis, by disqualifying the individual concerned.

Biological tests of this kind have certainly been made part of the routine of preventive medicine and they are in fact performed as indicated in special instructions. The question therefore arises of the reason which prevents their compulsory inclusion, in a short but precise form, in the regulations on fitness for flying duties. It is quite probable that there is, in actual fact, no serious omission and that the biological tests considered to be essential are carried out in Aviation Medicine Institutes. Nevertheless, it would seem advisable to lay down in the regulations the minimum content of the biological evaluation which should be carried out periodically, and quite irrespective of the place at which the medical fitness examination is conducted (Institute of Aviation Medicine or medical branch of air bases, both of whom could if necessary make use of the services of a hospital laboratory for any analyses required).

CHAPTER X

REQUIREMENTS COVERING CERTAIN SPECIFIC DISEASES

A. SYPHILIS

(a) Initial Examination

All the regulations require a serological examination as a matter of routine, using several different methods of sero-diagnosis. Instructions are generally given on the action to be taken in cases of doubt.

The text of the *French* regulations, quoted below, may be regarded as representative of the requirements laid down and the precautions taken in order to obtain results which are free from errors and beyond dispute.

"A serological examination must always be carried out, using at least three different methods of serological diagnosis (including two complement fixation reactions and one flocculation reaction). In the event of doubtful or contradictory reactions, a treponema immobilization test (Nelson test) or immunofluorescence should be performed."

The various regulations are almost identical. They differ only in points of detail of minor importance. The points common to them all are the following:

1. Any clinical evidence of active syphilis (primary, secondary or tertiary) or of congenital syphilis is a cause for rejection.
2. A positive serological reaction, confirmed by several tests, is a cause for rejection.
3. Visceral or nervous accidents, indicative of deep infection are cause for permanent rejection.
4. Precautions are taken if the subject is found to have a history of syphilis or if there is a positive serological reaction.

The regulations differ, however in regard to the type of precautions taken.

The *Belgian* regulations accept a candidate with a history of syphilis, provided the blood and the spinal fluid have shown a normal reaction for at least *two years* (supporting documentary proof to be supplied) and there is no mucocutaneous, visceral, cardiovascular, bony or nervous evidence.

Under the *French* regulations, a person found to have a history of syphilis or clinical evidence of it is declared temporarily unfit for a period of *six months from the date of the examination*. The candidate is acceptable after this period if the serological test is negative and providing he undergoes an annual serological test over a period of three years.

The same rule of requiring a six months' period of provisional suspension is found in the *Canadian* regulations, though without any reference to subsequent follow-up checks.

The *USAF* regulations do not specify a minimum duration for the period of negative checks of the serological reaction for cases of a past history of syphilis. The guarantees which they require are those which can be verified at the time of the examination. There are five conditions which must all be satisfied simultaneously to permit the acceptance of a candidate with a history of *primary* or *secondary* syphilis:

- (1) the candidate has no symptoms of the disease;
- (2) there are no signs of active disease nor of any sequelae;
- (3) serological tests and cerebrospinal fluid tests are negative;
- (4) there is a verified history of adequate antisyphilitic treatment;
- (5) there is no history or evidence of involvement of the central nervous system.

The *Norwegian* regulations have adopted this same text.

The *German* and the *UK* regulations, and also those of the *US Navy* follow practically the same pattern as the *USAF*: they do not require any minimum period of treatment with periodic checks, provided the treatment is found to have been adequate and efficient.

The *US Army* supplements the above five USAF requirements by stipulating a period of provisional unfitness following treatment.

This period is twice as long as that provided for in the French regulations, since it extends over *one year*.

(b) Periodic Examinations

Except for a few details the *Belgian* and the *French* regulations are identical. They provide for conditions which allow a return to flying duties — with limitations — during treatment, and during the post-treatment period of supervision.

A serological examination, using at least three different methods of serological diagnosis (including two complement fixation reactions and one flocculation reaction, in the French regulations) is performed regularly every two years in France, and every year in Belgium. In the event of doubtful or contradictory reactions, a treponema immobilization test (Nelson test) or immunofluorescence is carried out.

If clinical evidence of primary or secondary syphilis is found, or if a serological test performed for any reason is found to be positive, the subject is assessed as unfit for a period of *one month*. At the end of this period, during which attack treatment is given, the examinee concerned may be assessed as fit, if he has responded to the treatment and is free from any clinical or ophthalmological evidence of active syphilis, or any other symptom of this disease.

However, over a period of *two* years under the French regulations, and *three* years according to the Belgian regulations, his assessment of fitness is restricted to successive periods of six months.

At each of the six-monthly follow-up examinations at the unit, the examinee concerned must provide proof of the course of treatment he has been receiving: a serological check test is performed with, if necessary, quantitative reactions, a fall in the rate of the reagins indicating a regression of the disease.

In the event of further clinical or serological evidence following a return to duty, the *Belgian* regulations state that the subject will again be assessed as unfit for a period of three to six months.

The *French* regulations are more flexible: they accept that the persistence of a slightly positive or doubtful serology, even when a Nelson test is 100 per cent positive, should not be a cause for unfitness of a subject who provides proof of regular checks or treatment. They do however add that in special cases it might be considered advisable to examine the spinal fluid. If the subject refuses to undergo this test, he is assessed as unfit.

It is obvious that in both these sets of regulations, as moreover in all the others, visceral accidents, indicating deep and long standing infection, and quaternary syphilis, even though treated, render the airman permanently unfit for flying duties.

The *other* regulations do not give such a detailed description of the various stages in the treatment or of the decisions appropriate to each of them. The requirements for cases arising among serving aircrew personnel are identical to those for candidates for enlistment undergoing their initial examination.

Finally, the five conditions enounced in the USAF regulations are also used as criteria for authorising a return to flying duties, if treatment has been found to be effective.

With the exception of the *US Army* regulations, these other regulations do not stipulate any special provisions for periodic checks of treatment given. It was probably considered that such matters could be dealt with in separate instructions or directives.

It should be noted that the USAF regulations, the German and the Norwegian regulations, require a serodiagnosis at each periodic examination.

(c) Conclusions

As was to be expected, the various regulations are identical in their broad outlines. As soon as there is a reference to details for implementing the requirements, however, it is obvious that these differ, though not to such an extent as to constitute differences of major importance. Since these rules are in no way absolute but rather in the nature of guidelines, it is unlikely that a greater degree of standardisation can be achieved, bearing in mind particularly the very many different types of clinical cases which arise and the varied responses to treatment, as well as the continual appearance on the market of new and extremely powerful drugs.

B. MALARIA

(a) Initial Examination

The *USAF* regulations are very clear and very precise. It is no surprise to find the same requirements in a very similar form in the majority of the other regulations.

The *USAF* requires the rejection of subjects suffering from recurring malaria which has not responded to treatment.

A history of malaria is not disqualifying provided the following conditions are present:

1. there is a verified history of adequate antimalarial treatment;
2. the subject has been free of malaria symptoms for at least *six months* preceding the medical examination, without the use of antimalarial drugs;
3. the number and structure of the red blood cells are normal, and the haemoglobin content is at least 12 g/100 ml of blood;
4. a thick blood smear has not disclosed the presence of malaria parasites.

The *US Army* and the *Norwegian* regulations are similar in all respects to those of the *USAF*.

The *Belgian* requirements also follow the *USAF* but specify in addition the absence of splenomegaly.

The *UK* has similar requirements, except, however, in regard to the haemoglobin content.

Three sets of regulations (the French, the German and the *US Navy*) differ from this group of five, not so much in their substance as in their form. The texts in both of them are of a general nature, very brief, and with no details to help their interpretation.

In the *US Navy* regulations, recent attacks of malaria are disqualifying.

Under the *German* regulations, any candidate suffering from malaria on the basis of medical history is temporarily unfit.

Under the *French* regulations, any candidate who has previously had malaria is not acceptable unless there are no signs of anaemia or of splenomegaly.

Finally, the *Canadian* regulations make no mention of the problem of malaria.

(b) Periodic Examination

The most precisely worded requirements for lifting the temporary suspension from flying, after treatment, appear in the *US Army* regulations. It is the text, common to the *USAF* and the *US Army* for the initial examination, but adapted to meet the requirements for serving flying personnel.

"A history of malaria is a cause for unfitness for flying duties until adequate therapy, in accordance with existing directives, has been completed. The duration of suspension is an individual problem and will vary with the type of malaria, the severity of infection and the response to treatment. However, personnel may not fly unless afebrile for 7 days, the red cells are normal in number and structure, the blood haemoglobin is at least 12 grams per cent, and the thick smear (to be done if the disease occurred within one year of the examination) is negative for parasites.

A thick smear and a medical examination will be made every two weeks for at least 3 months after all antimalarial therapy has been stopped."

The *Belgian* regulations repeat practically the same requirements. They state, in fact, that a blood test and a medical examination must be repeated every *two weeks*; a favourable decision can be taken only after all the clinical and haematological signs have disappeared.

The other regulations confine themselves to repeating texts relating to the initial examination and applying them to the temporary unfitness of serving flying personnel while under treatment.

The *UK* requirements include a new element: in cases complicated by haematuria during treatment carried out by means of modern antimalarial drugs, the airman will remain unfit for service in a tropical climate, after treatment.

(c) Conclusions

Two types of texts are found:

1. very detailed and very precise texts;
2. texts which are confined to general statements.

The various details, when they are in fact quoted, are so similar that some degree of standardization could quite easily be achieved. Furthermore, the texts which are limited to general statements are not contrary to the texts of the regulations which have tried to present the maximum amount of information.

C. CHRONIC INTOXICATION (ALCOHOLISM, NICOTINE POISONING)

All the regulations require the rejection of candidates who, at the time of the *initial examination*, show signs of chronic intoxication, affecting function in a manner likely to reduce flight safety. The chronic signs referred to in particular, since they are quoted in all the regulations, are those of alcoholism "even though", as added in the *French* regulations, "laboratory tests are appreciably normal".

Nicotine poisoning is quoted specifically only in the *Belgian* regulations, though it is true that it is included in the general statements of the other regulations.

With regard to chronic alcoholism in *serving flying personnel*, its incompatibility with flying is quoted in all the regulations. The various Air Forces have issued further special directives in this connection; they contain the measures which must be attempted to rid the airman of his intoxication and the action to be maintained during and after treatment.

The *French* have introduced an extremely useful text which covers the main points of the basic principles which should underlie the action taken by doctors at air force units and by medical experts. It is considered helpful to quote this text in full, as follows:

"Whenever alcoholism is reported, either by the air force unit doctor, or by the command authorities, the assessing medical officer must try to discover its stigmata and may, if necessary, prescribe a period of observation in a special department of a hospital. An assessment of fitness can then be considered only if all the tests performed are satisfactory. The validity of an assessment of fitness must in any case be for a limited duration."

D. AIRSICKNESS

Two characteristic factors which must be investigated before any decision can be taken are mentioned in official texts:

- (a) An excessive sensitiveness to airsickness must be unimprovable.
- (b) The aetiology may be psychogenic or labyrinthine. The advice of a psychologist and of an E.N.T. specialist is therefore essential.

Some of the regulations mention both these factors. Others omit them and make only a very general reference to this subject.

1. The first group of regulations covers the *French* regulations and the *USAF* regulations.

(1) *French* regulations

At the *initial examination* any history of airsickness must be taken into consideration. The latter is not likely to entail rejection unless there is evidence after an examination, as necessary by a psychologist, that this airsickness cannot be improved.

At the *periodic examinations* it should be remembered that, in the majority of cases, airsickness disappears after a certain period of adaptation to flying. It cannot become a cause for rejection unless there is evidence that it is of a type which is incapable of improvement, and is caused either by adjustment disorders, or labyrinthine disorders. The opinion of a psychologist and of an ear, nose and throat specialist is then essential before an assessment can be made.

(2) *USAF* regulations

At the *initial examination*, any history of airsickness must be completely explored. The final decision of qualification will be made by the Surgeon, Air Training Command, or Air Force Academy.

At the *periodic examinations*, airsickness is a cause for rejection only if of such chronicity or severity as to interfere with flying duties. A psychogenic aetiology should be suspected when airsickness develops in persons not previously affected.

The use of motion sickness drugs by flying personnel is forbidden. If these drugs are prescribed for any other disease, they are normally a cause for temporary unfitness until treatment is no longer necessary and the possible effects of the drug have disappeared. The only exceptions to this paragraph are those authorized in the regulations AFR 160-12.

2. *The second group contains less detailed texts.*

- (1) The *US Army* stipulates rejection for cases with a past history which is more severe than isolated episodes without emotional involvement, or a past history which has already previously involved elimination from flying training at any time.
- (2) The *US Navy* and *Canada* make no reference to this problem in the text of their regulations on assessing medical fitness.
- (3) *Belgium* and *Germany* have a brief text.

Under the Belgian regulations excessive sensitiveness to airsickness is a cause for elimination.

The German text is confined to a statement requiring the rejection of any candidate or any member of flying personnel who has a persistent sensitiveness to airsickness, but requires, before any decision of unfitness, that the individual be submitted to a special psychological examination.

- (4) The *UK* regulations mention the importance of inquiry into the past history of various forms of motion sickness. They call for vestibular tests if an aetiology associated with vestibular pathology is suspected. They remain completely silent on the psychogenic aspects, which are, however, of great importance in many trainee pilots, and also on the part to be played by the psychologist, in addition to that of the ear, nose and throat specialist.

The texts referring to airsickness run as follows:

"A candidate will be rejected if he has a history of train sickness, car sickness, severe and persistent seasickness, a dislike of swings, roundabouts or switchbacks. A detailed investigation must be carried out to assess sensitivity to these forms of kinetosis. Rotation tests or caloric tests, as well as posture tests to detect nystagmus are used solely to evaluate vestibular responses, if some pathological injury to the vestibule is suspected."

3. **Conclusions**

The problem of airsickness is an important one, as witness the percentage of subjects who are rejected because of it during the first few weeks of their flying training.

It would therefore appear that a special heading ought to be devoted to it in the regulations. These provisions should stress the importance to be attached to any history of motion sickness in any of its forms, and should, above all, contain precise directives in connection with the various aetiological factors which may be involved.

Any text of this nature should consequently specify the methods of investigation to be used prior to any decision to assess a subject as unfit, whether permanently or temporarily.

It is true that these problems are often covered in special directives addressed by the higher medical authorities to their examining medical officers. Nevertheless, remembering the bitter feelings which elimination from a flying training school always arouses in a trainee pilot who has suffered from airsickness, and considering the efforts made by him to have his training tests spread over a longer period, the existence of precise provisions as laid down in regulations can prove to be of particular value. They provide a strict support for a decision of unfitness and give it an unassailable character of scientific objectivity.

In spite of their relative conciseness, which is compensated by the additional data provided in special technical instructions, the texts of the *USAF* and the French regulations take account of all these factors, both medical and psychological, which deserve very special consideration by all medical assessors.

In any attempt to harmonize the regulations, these texts are undoubtedly the most comprehensive, and consequently obvious choices to serve as a reference basis.

CHAPTER XI

DENTAL EXAMINATION

A. INITIAL EXAMINATIONS

For the *initial examination*, the following three main points appear in all the regulations:

- (a) the teeth must be in good condition;
- (b) the dental articulation must be normal;
- (c) removable or temporary prostheses are not acceptable.

However, the French regulations allow these removable prostheses in candidates awarded a Class 2 medical fitness standard, that is, candidates for training as navigators, bomb-aimers, radar operators, candidates for training as navigators of transport aircraft, flight engineers, female flight attendants, military reserve pilots or air gunner observers. Removable or temporary prostheses are therefore not acceptable in the case of candidates for training as *pilots*.

The German regulations are different on this point: they admit, not only fixed prostheses, but also removable temporary prostheses, in the case of candidates for flying personnel.

The following are causes for rejection:

1. Pronounced alveolo-dental pyorrhea, alveolo-dental arthritis, active dental caries which have not been attended to, extensive loss of the set of natural teeth to such a degree as to constitute a serious obstacle to mastication and to interfere with satisfactory nutrition.

Only two sets of regulations — the Belgian and the French — use the *coefficient of mastication* as a criterion.

This brings a considerable element of objective precision to the concept of fitness or unfitness.

The coefficient of mastication of the individual is therefore determined, according to these two regulations, in all cases of loss of teeth or carious teeth, by assigning to each tooth the following coefficients:

- (1) median incisor 2
- (2) lateral incisor 1
- (3) canine..... 4
- (4) first pre-molar 3
- (5) second pre-molar 3
- (6) first large molar 6
- (7) second large molar 5
- (8) wisdom tooth..... 1

As the total coefficient is 100, the coefficient lost is obtained by adding together the coefficients for the teeth lost, plus half these coefficients for the opposed teeth when there are any.

Any loss of teeth for which the coefficient exceeds 50% entails the rejection of the candidate. Calculation of this coefficient takes into account any fixed prostheses which are in good condition and well fitting.

2. Deformities or chronic lesions of either of the jaws or of the articulation of the lower jaw likely to interfere seriously with mastication.
3. Severe protrusion and irregularity of the jaws which would prevent satisfactory occlusion of the mouth or adequate wearing of an oxygen mask, or interfere with clear speech.

B. PERIODIC EXAMINATIONS

At the *periodic examinations*, the same rules are applied to justify an assessment of *temporary* unfitness until defects have been corrected by treatment.

Removable prostheses are not generally permissible. Some of the regulations allow them for some categories of flying personnel. The French regulations, for example, allow them for the categories which were granted this tolerance at the initial examination. Pilots are excluded from this rule.

The German regulations allow a complete prosthesis at the upper maxillary for pilots and other aircrew flying in jet aircraft equipped with ejection seat. They allow a complete prosthesis at the upper and/or lower maxillaries for the other classes of flying personnel.

C. CONCLUSION

On the main points, all the regulations are in fact in agreement. It is important, however, to draw attention to the concept of the "coefficient of mastication", when assessing the significance of any loss of the natural teeth, which appears in the French and the Belgian regulations.

Because of the numerical data which it provides, this element is a criterion of objectivity which deserves consideration with a view to its inclusion in all the other regulations.

CHAPTER XII

HEAD - FACE - NECK

Serious deformities of the face, whether congenital or traumatic, which may interfere with the wearing of an oxygen mask are a cause for rejection. This very special point is quoted in all the regulations. Those for the USAF wisely add to the list of causes for rejection any interference with the wearing of the protective helmet or any other flying equipment.

As already noted when referring to other headings, the American regulations give a long list of deformities and diseases which are causes for rejection for flying duties. The others are much less detailed, do not contain exhaustive lists and are confined to general statements which obviously cover such deformities and diseases.

An exception is made in the case of injuries to the head, which were dealt with in the chapter on neurology (see Chapter VIII).

CHAPTER XIII

BLOOD AND BLOOD-FORMING TISSUES

All regulations lay down which blood tests are to be carried out at each examination (initial and periodic examinations). Some of them are related to the detection of atheroma and degenerative vascular diseases and have been described in Chapter IX.

Others are compulsory for each candidate and for each member of the flying personnel:

- count of the red blood cells,
- count of the white blood cells,
- differential count of the white blood cells,
- haemoglobin concentration,
- erythro-sedimentation rate.

Determination of the blood group is usually carried out at the initial examination or, at the latest, before the beginning of flying training.

The *USAF* regulations give a list of the diseases of the blood and of the blood-forming tissues which are causes of temporary or permanent unfitness, depending on whether the pathological conditions can be corrected up to complete healing by treatment or not. These diseases, grouped under six general headings, are usually causes of permanent unfitness:

- A. Anaemia. However, temporary conditions due to a simple loss of blood entail only temporary unfitness for the duration of the treatment.
- B. Haemorrhagic states.
- C. Leukopenia.
- D. Myeloproliferative diseases; Hodgkin's disease.
- E. Splenomegaly, except when the cause is known and can be remedied by treatment.
- F. Thromboembolic diseases.

These provisions are identical in the *other two sets of American regulations*, and in the *Norwegian regulations*.

They are much less detailed in the regulations for other countries.

In spite of recent therapeutic advances, allowing patients to achieve a longer remission in the evolution of some of these diseases (e.g. Hodgkin's disease) the severity and the prognosis of the majority of these diseases place them among the obvious causes for rejection.

Two points receive special mention:

(a) *Loss of Blood*

Under the American regulations, a loss of blood of 200 cc or more is a cause of temporary disqualification from flying duties for at least 72 hours. This rule also applies to blood donors. Disqualification must be continued for a longer period at the discretion of the responsible flight surgeon.

(b) *Drepanocytosis* (sickle cell anaemia)

Under the American, German and French regulations, drepanocytosis and hereditary haemoglobin abnormalities entail disqualification from flying duties.

Drepanocytosis is a structural abnormality of the haemoglobin (S haemoglobin), presenting a racial character and an hereditary transmission. This haemoglobin offers a marked sensitiveness to hypoxia. When the haemoglobin is in the reduced form, the red cells usually assume a sickle shape. Sickling is responsible for capillary thrombosis in many organs and for infarcts in pulmonary or splenic tissues or in bones.

Under the French regulations, tests for the detection of drepanocytosis are mandatory for all candidates of overseas origin. This detection is carried out by electrophoresis and is completed by the test of S haemoglobin precipitation in buffer phosphate solution (2.8 M and p.h. 6.8) and by the Emmer test, reproducing sickling in vitro.

CHAPTER XIV

SKIN DISEASES

The skin diseases, acute or chronic, which are causes for rejection for flying duties are any diseases which render a subject unfit for military service.

To this must be added any extensive, deep or adherent scars which hinder or interfere with the wearing of flying equipment.

The USAF regulations present a very exhaustive list of these dermatologic conditions, resulting in unfitness for flying duties. The other regulations have more concise texts. But, from a comparative study of the various regulations, there would not appear to be any fundamental differences between them.

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CHAPTER XV

CONSTITUTIONAL DISEASES – TUMOURS – INTOXICATIONS – PARASITOSES AND MISCELLANEOUS DISEASES

The American regulations quote a number of diseases which, if found in a candidate for flying duties or in a trained aircrew member, are reasons for declaring them unfit for such duties.

The diseases in question are constitutional diseases, malignant tumours, intoxications, allergy reactions, parasitoses and miscellaneous diseases the aetiology of which is still not fully known. They are rarely mentioned in the regulations of the other countries.

This gap does not however affect the medical assessor. The majority of these disease are serious, chronic or are fatal. Other conditions, which are curable, are causes for temporary suspension from flying during the period of the treatment. The final decision on rejection for flying duties will be governed by the results of the treatment, if the latter has not been effective.

It should be noted that under the USAF regulations an aircrew member who has a history of basal cell carcinoma can be maintained on flying status if the tumour has been adequately excised; a decision taken on this basis does not require to be submitted for the special approval of HQ USAF.

Other malignant tumours, on the other hand, which have been adequately treated, are always initially a cause for disqualification for flying duties. This ban on flying can be lifted only if an assessment of fitness is given by HQ USAF, the sole authority competent to take such a decision in these circumstances.

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CHAPTER XVI

EYES AND VISION

The following three elements must be considered separately:

- A. Pathology of the eyeball and its adnexae;
- B. Visual function;
- C. Colour perception.

A. PATHOLOGY OF THE EYEBALL AND ITS ADNEXAE

(a) Initial Examination

Under the *Belgian* regulations, the eyeball and its adnexae should be examined, after the pupil has been dilated by a mydriatic, so that the whole of the fundus can be seen. The examination includes a split lantern test and an examination using an electric ophthalmoscope.

The examination must show the absence of any pathology or anomaly of the fundus, the media, the iris, the conjunctiva, the eyelids, the lachrymal apparatus or the orbit, which would be likely to interfere with the exercise of vision or which may be progressive.

The absence of an eye is a cause for rejection at the initial examination.

The above constitutes the general basis for the requirements found in all the regulations. It is, of course, supplemented by special remarks which in some of the regulations are quite lengthy.

For example, the *French regulations* require a systematic examination, after the pupils have been dilated by a mydriatic, for any anomalies likely to cause detachment of the retina. The discovery of micro-aneurisms in the fundus will necessitate a test of provoked hyperglycaemia. Minor peripheral chorioretinal alteration, however, may be acceptable, provided it has scarred and does not affect the visual field. In addition, other tests must be made to establish that the causal disease is not longer active.

The *UK regulations* stress several aspects which should be of interest to the medical examiner.

1. Ptosis which interferes with vision is a cause for rejection. The candidate is acceptable after surgical correction.
2. Uveitis and corneal diseases, even when they do not affect visual acuity, are often chronic, and require to be thoroughly investigated, taking into account this factor of chronicity, before a candidate can be assessed as fit.
3. After surgical intervention on the lachrymal passages a minimum period of *six months* should elapse before a decision can be taken to declare the subject fit, if the results of surgery have proved satisfactory.
4. Any pathological condition of the fundus entails rejection. The appearance of the fundus should be carefully considered, particularly in cases of myopia.

Any changes in pigmentation which are active, any sign of stretching or thinning of the retina, or any degenerative changes in the retinal periphery are causes for rejection.

The *American* regulations (USAF, US Army and US Navy) provide a very detailed list of the anomalies and pathological conditions of the various media of the eye which are incompatible with fitness for flying duties. The concern to supply precise details, with figures whenever possible, is an essential feature of such a description. For example: pterygium which encroaches more than 1 mm on the cornea interferes with vision or is progressive (as evidenced by marked vascularisation and a thick elevated head) is a cause for rejection.

Glaucoma and preglaucoma imply the rejection of the candidate for flying duties at the initial examination. The following details are given:

- Glaucoma, as a cause for unfitness, is characterised by an intraocular tension of more than 30 mm Hg, or by the secondary changes associated with glaucoma which have occurred in the optic disc or the visual field.

- A preglaucoma condition may be established when, during two or more tests, an intraocular tension of at least 22 mm Hg is noted, or if there is difference of more than 4 mm Hg between the tension in the two eyes.

It should also be pointed out that a history of chorioretinitis, uveitis or optic neuritis entails the rejection of the candidate for flying duties at the initial examination.

The *Norwegian* regulations are similar to those of the USAF.

The *German* and the *Canadian* regulations are very similar to those of the USAF when listing the causes for rejection. The majority of the items are the same, some of them being less detailed, but the interpretation given to them does not differ from that found in the USAF requirements.

(b) Periodic Examinations

In the three *American* sets of regulations the requirements are the same as for the initial examination. The same applies to those for *France*, *Canada* and *Norway*.

The other regulations leave the door wide open to the acceptance of certain anomalies provided flight safety is not prejudiced.

This relaxation of the rules takes the form of an assessment of fitness with limitations.

The *Belgian* regulations state that incipient chronic diseases of the media and the membranes of the eye are compatible with flying provided the visual acuity standards are met. When the decision is made, the medical category assigned will, however, always be a category to which limitations are attached.

For the various classes of serving flying personnel the *German* regulations require a period of temporary unfitness during treatment for certain diseases, such as iritis, cyclitis, retinitis, optic neuritis. A decision of fitness for flying can be taken after recovery, if the disease has occurred for the first time, if recovery is complete with full maintenance of the visual function, and if the aetiology and development of the disease are such as to exclude any recurrence.

Some diseases which have been treated surgically (detachment of the retina) may be followed by an assessment of fitness for flying. Such a decision will not, however, be taken until six months after completion of the surgical treatment and only if there have been no complications, if there is no risk of any recurrence of the disease and if the functional efficiency still enables the airman to meet the visual standards for his category.

Under the *UK* regulations small unilateral lesions at the retinal periphery which have healed may be acceptable for flying, but only on the favourable opinion of the consultant ophthalmologist.

(c) Conclusions

The regulations which give a detailed list of the pathological conditions of the eye present a high degree of unity where standards relating to the pathology of the eyeball and its adnexae, on which an assessment of unfitness is based both at the initial examination and the subsequent periodic examinations, are concerned.

The comments joined to the general statements to which the other regulations confine themselves do not appear to contain any differences in regard to assessment. The detailed information, of the type quoted above, provides the medical assessor with guidance on the decisions to be taken in cases where there may be some doubt in regard to fitness.

If there is to be any harmonisation of decision, it would appear advisable, however, to adopt the system in which the pathological conditions are presented in detail.

This is, in fact, the system found in the majority of the regulations. It would seem that the pathology of the eye lends itself much more readily to such a description than the diseases related to other medical disciplines.

B. THE VISUAL FUNCTION

Defects in the visual function constitute the most important cause for rejection at examinations for the selection of flying personnel. The tests for assessing this function must be such that their validity is beyond dispute.

If the results of such tests are to be comparable, it is essential that the methods of examination should be standardised in all the examination centres, or at least that they should give results which are capable of the same interpretation.

The majority of the Air Forces have formulated instructions on the methods to be used when testing the visual function, taking into account the types of equipment in general use.

The present study will not concern itself with the details of such methods, but will be restricted to a few short statements in this connection.

It should be pointed out, however, that in the USA, the Army-Navy National Research Council Vision Committee has prepared two Manuals which are used by all the medical services of the armed Forces. One is entitled "Manual of instructions for testing visual acuity", and the other "Manual for testing heterophoria and prism divergence at near vision".

(a) Examination Techniques and Testing Instruments

1. According to the *French* regulations, *distant vision* must be measured using the series of Landolt optotypes presented by means of the Beyne optometer, illuminated to 15 lux and examined at a distance of 5 metres.

In all the other regulations distant vision is measured by means of the series of Snellen optotypes, or similar optotypes, placed at a distance of 20 feet (6 metres). The American Armed Forces Manuals require the optotypes to be illuminated to 12 foot-lamberts on average; the illumination must in no case be less than 10 foot-lamberts, or more than 15 foot-lamberts. The average lighting in the examination room should on average be 4 foot-lamberts and should never be less than 3 foot-lamberts or more than the degree of illumination of the optotypes.

The *RAF* Manual states that the optotypes should not be illuminated to more than 20 foot-candles, but gives no indication of the maximum illumination in the examination room.

The *Canadian* regulations state that the correct intensity of illumination of the optotypes should be about 10 foot-candles.

The results of the visual acuity test are indicated as a fraction in which the numerator expresses in feet the distance at which the optotypes are read, and the denominator is the value shown opposite the lowest line which the subject reads without error. Thus, a person reading the line of optotypes indicating 30 feet, at a distance of 20 feet, will have a visual acuity of 20/30.

To be credited with the degree of visual acuity related to the line read, the subject must have read correctly 75% of the letters in that line, according to the *American* regulations.

The *RAF* Manual, however, sets a stricter rule: the line of smallest types read correctly and *completely* determines the denominator of the fraction used in recording visual acuity.

The American Armed Forces and those of other countries (in particular Canada) use instruments which have been approved for testing the visual function (Machine Vision Tester); this method gives comparable results. The optotypes to be read are in the testing instrument, but their presentation is similar to that used for reading at a distance of 6 metres.

The concept of *binocular visual efficiency* (BVE) is sometimes used. This is a system in which the overall visual acuity of *both* eyes is considered, rather than that of each eye separately. The results are expressed as a percentage. Binocular visual efficiency is determined by measuring the visual acuity of each eye separately using the Snellen optotype method and expressing the result as described above. A conversion table is then used to find the percentage of binocular visual efficiency. (cf Table 4 overleaf)

2. *Near vision* is not used in the *French* standards.

The German Air Force uses the Niden charts.

The American regulations require the use of charts (Chart Set, Vision Acuity Testing, Near Vision) placed at a distance of 14 inches, or the use of standard vision test apparatus (VTA-ND-Vision Test Apparatus - Near and Distant).

Table 5 (overleaf) compares the results obtained with the US apparatus both with those obtained by using the Jaeger chart, still sometimes employed, and those found from the Snellen chart.

The *UK* regulations refer to the use of a chart called the N chart.

The *Belgian* Air Force uses the Jaeger chart.

3. The *Near Point of accommodation* and the *Near Point of convergence* are fixed in *France* by means of a "proximeter".

The German, Belgian and Canadian regulations give no indication of the technique used for determining these points.

The American regulations advocate the use of the *Prin* rule, while the *RAF* uses the *RAF Near Point* rule.

TABLE 4
Table of Binocular Visual Efficiency

		Right eye							
		$\frac{20}{20}$	$\frac{20}{30}$	$\frac{20}{40}$	$\frac{20}{50}$	$\frac{20}{70}$	$\frac{20}{100}$	$\frac{20}{200}$	$\frac{20}{400}$
Left eye	$\frac{20}{20}$	100	98	96	94	91	87	80	76
	$\frac{20}{30}$	98	92	90	88	85	81	74	69
	$\frac{20}{40}$	96	90	84	82	79	75	68	64
	$\frac{20}{50}$	94	88	82	77	73	70	62	58
	$\frac{20}{70}$	91	85	79	73	64	60	53	49
	$\frac{20}{100}$	87	81	75	70	60	49	42	38
	$\frac{20}{200}$	80	74	68	62	53	42	20	16
	$\frac{20}{400}$	76	69	64	58	49	38	16	3

TABLE 5
Equivalent Results of Near Visual Acuity Measurements According to the Type of Chart Used

<i>Snellen chart</i>	<i>USA Standard chart</i>	<i>Snellen metric scale</i>	<i>Jaeger chart</i>
20/20	14/14	0.50 m	J - 1
20/25	14/17.5	0.62 m	J - 2
20/30	14/21	0.75 m	J - 4
20/40	14/28	1.00 m	J - 6
20/50	14/35	1.25 m	J - 8
20/70	14/49	1.75 m	J - 12
20/100	14/70	2.25 m	J - 14
20/200	14/140	—	—

4. Tests for *heterophoria* are carried out with a phorometer or a Maddox cylinder at a distance of 5 metres (France — Germany) or 20 feet (the other regulations). The RAF and the French Air Force also suggest the Maddox Rod test at a distance of 35 cm. Fusional control power is measured with a prismoptometer (Germany). The red lens test is used in the three American armed services.

5. *Depth perception* is measured by means of stereograms, of the Verhoeff or similar type in the American, French and German regulations. The French regulations require, as a minimum standard, a stereoscopic parallax of 20".

The American apparatus is referred to as the DPA-V (depth perception apparatus — Verhoeff). The Howard-Dolman apparatus is also mentioned in the French regulations and in those of the USAF.

Measurement of depth perception is not required in the *UK* regulations or in those of the Canadian Air Force.

Nor is it required by the Belgian regulations as part of the visual standards for medical fitness. It is, however, carried out during the medical examination and the results of the reading of the stereograms are incorporated in the battery of psychosensory and psychomotor tests, designed to assess the candidate's chances of success at the elementary flying training school.

6. Tests to ascertain *resistance to glare* are mandatory in *France*, at the initial examination, for all candidate pilots. They are also performed every five years as periodic tests on all pilots. The method of Baillart is employed. After the measurement of the visual acuity, an ophthalmoscopic examination of the macular area is carried out, using a maximum light intensity during 30 seconds. The time needed to recover the initial visual acuity is then measured. The normal time must not exceed 60 seconds. If the result obtained is not normal, but if a complete examination of the macular function does not reveal any abnormality, the subject is proposed for flying duties limited to transport aircraft.

Such tests are also conducted in *Germany*, at the initial examination. They are not used in the American Forces, the RAF, the Belgian Air Force, the Canadian Air Force or the Norwegian Air Force.

7. The *night morphoscopic threshold* is measured in the *French Air Force* at the initial examination, using a Beyne scotometer. This measurement is performed at a distance of 75 cm, after a preadaptation of 45 minutes. If the subjects are wearing red lenses, the measurement is performed after a preadaptation of 30 minutes.

In the *German Air Force*, this test is not routinely carried out at the initial examination, but only if the family or personal history, the state of the refracting media or fundus changes point to dark adaptation deficiency, or when this condition is obvious from the result of the test measuring retinal resistance to glare, or from behaviour in the dark.

The instrument used for the test is the *Goldmann-Weekers adaptometer*. The tests lasts 15 minutes, during which period dark adaptation should remain within the 2 sigma standard curve.

The USAF and the US Navy do not conduct this test as a matter of routine, but only in circumstances similar to those laid down in the German regulations.

The equipment used is the *Landolt adaptometer*. The operating technique is simple. In a darkened room, after dark adaptation, the subject must describe correctly the four items presented to him, and then eight of the ten items presented. The test starts at a distance of 5 feet (1.50 metre). The presentations are then gradually moved further away until the subject fails to give eight correct replies out of ten. The result is based on the maximum distance at which the subject still provides eight correct replies out of the ten:

- 10 feet or more Superior
- 5 to 9 feet Satisfactory
- less than 5 feet Unsatisfactory.

The other regulations stipulate that flying personnel should have normal night vision, but do not specify any particular test method.

8. The *visual field* is measured with a *Goldmann campimeter*, or any similar instrument, or by the simple technique of the confrontation test.

9. *Intraocular tension* is measured in *France* when the subject reaches the age of 35.

In *Germany*, and in the *US Army*, it is measured if the subject is over 40.

In the *USAF* and the *US Navy* it is compulsory from the age of 39.

The *French Air Force* uses the *Goldmann aplanatometer* and the *American Forces* the *Schiotz tonometer*.

10. Conclusions

Ophthalmological examination methods are precise, well standardised and allow very little scope for any personal interpretation by the examining Medical Officer. It is therefore rather surprising to find different ways of interpreting the results of *distant visual acuity* (see *USAF* and *RAF* texts). Does visual acuity correspond to the line which is read without any errors (*RAF*) or the line which is read with only 25% errors?

When one considers the extremely important consequences represented by a difference of 1/10 in the results of the reading of the optotypes, it would seem that there are grounds for justifying some standardisation of doctrines.

Faced with the concern for precision in the use of apparatus, it is essential and logical that the freedom of interpretation allowed for the human factor, in the person of the user of the apparatus, should be eliminated or reduced to a minimum.

Measurement of *near visual acuity* offers an increasing number of different methods of conducting this test. The comparative Table given above is not complete. It should have included the chart used by the UK and that adopted for the German Air Force.

Another point which deserves consideration is the place to be given to the tests used for assessing ability to appreciate *depth and distances* as part of the *medical fitness tests* in the field of ophthalmology. This amounts to questioning the significance and the practical value of these tests when selecting flying personnel. It is noted, in fact, that the use of tests to assess ability to appreciate distances or depth does not appear in three of the regulations studied. This suggests that the usefulness of such a determination is considered to be at least doubtful, or debatable, if not worthless. As for the methods used, in addition to stereograms of the Verhoeff type, the Howard-Dolman apparatus still appears in the French and USAF regulations, whereas for more than several decades the significance of this test in the selection of flying personnel has been a matter of some debate, and has never become established.

The perception of distances and depth is based both on the *mental* perception of disparate points on the retina (physiological diplopia) in relation to the normal exercise of binocular vision, and on the action of a series of factors which are acquired through experience and refined through training, and which are monocular factors (movement parallax, land perspective, air perspective, relative dimensions of retinal images, etc.). There is no doubt about the part played by physiological diplopia in the perception of distances and depth by the airman, but an important role is also being assigned today to monocular factors.

This is particularly so in the case of the constituent elements of air perspective and, in relation to landing, of the movement parallax, since the pilot is in a vehicle which is constantly moving. J. Gibson and Jongbloed have been at pains, in support of this opinion, to refer to the case of one-eyed pilots (e.g. Wiley Post). Binocular vision is therefore not essential for making a correct landing, providing, however, the pilot has received suitable training, that is, that he has had time to become accustomed by experience and training to the part played by monocular factors in air and ground perspective.

The assessment of far distances, something which is a normal feature of flying, involves in particular a comparison with known points of reference or with known objects the size of the image of which enables a pilot to estimate distance.

Such considerations lead to the deduction that any evaluation of an airman's ability to assess distances and depth is of no practical significance if based solely on the mental perception of disparate points on the retina (physiological diplopia), while disregarding all the other factors which, during flying, are of equal if not greater importance than this single binocular factor now required to be tested.

It is therefore not without good reason that Air Forces have not agreed that subjects should be disqualified by reason of tests whose significance has yet to be proved, both from the aspect of flying training and flight safety.

With regard to the Belgian concept which incorporates the results of stereogram reading in the series of psychosensory and psychomotor tests, after validating their coefficient of importance in relation to the criterion of success at the elementary flying training school, it would seem that this procedure has greater justification than that under which such results may prove disqualifying in the frame of an ophthalmic examination. The reply given after examining stereograms is, in fact, a purely *mental* act, which, although certainly requiring a high degree of binocular fusion, also depends – to a large extent – on what J. Duguet has described as the calling up of the images presented for mental analysis. Thus, the logical place for this kind of test is not among those which verify the *physiological* aspects of the visual function, but rather in a set of psychosensory tests in which *mental analysis occupies its rightful place, which is one of predominance*.

A test for tolerance to glare, a mandatory requirement in France for all candidate pilots and repeated every five years, is not conducted elsewhere, except in Germany, and then only at the initial examination. It would therefore be of value if the positive contribution of this test to flight safety could be proved, so that its use – with or without a specified period for its repetition – could be extended to the other Air Forces.

(b) Analyses of Visual Standards

It is proposed to follow the same pattern for each of the regulations, when indicating the respective visual standards laid down. This will facilitate a comparison of factors of the same kind. Minor details have been omitted whenever they are not of fundamental significance for the present study.

1. France

There are five visual standards. These standards must be met by candidates before being accepted for certain flying duties, and by already trained aircrew members before they can exercise such duties. (cf. Annex 1.)

(1) Visual Standard 1 (VS/1) [French initials: SVA/1]

This is a reference standard which is higher than the requirements at present in force for all duties. Some of its requirements are repeated in all the other standards.

(a) Visual acuity, measured *before* instillation of a cycloplegic, must be 10/10 for each eye separately, uncorrected by glasses.

After instillation of a cycloplegic, compulsory for all candidates, an objective refraction examination must show that total hypermetropia does not exceed 1.50 dioptres, that astigmatism is not more than 0.75 dioptre, and that there is no myopia.

(b) The near point of accommodation, depending on the age of the subject, must not be further than:

- 8 centimetres at 20 years of age;
- 12 centimetres at 30 years of age;
- 17 centimetres at 40 years of age;
- 28 centimetres at 45 years of age.

The near point of convergence must not be further than 8 centimetres.

(c) Any esophoria or exophoria which exceeds 6 prism dioptres, or any hyperphoria greater than 1 prism dioptre, is disqualifying, unless an orthoptic examination reveals satisfactory fusion amplitude and a low pressure chamber test at a simulated altitude of 3,500 metres for 20 minutes (without use of an oxygen inhalator), and a rate of climb of 10 metres/second, does not lead to any objective diplopia.

(d) The field of vision, at the periphery and in the centre, must be satisfactory.

(e) Depth perception must be satisfactory.

(f) The night morphoscopic threshold must not be more than 0.12 candle/square hectometre up to the age of 30, nor more than 0.18 candle/square hectometre after that age; the examination must be conducted after 45 minutes complete dark adaptation.

(g) Intraocular tension, as measured with the Goldmann aplanometer, must not exceed 21 mm Hg.

If the intraocular tension is above 21 millimetres of mercury, the measurement must be repeated on several occasions during the same day and an inventory must be drawn up in order to establish if signs of the glaucomatous pictures are present. In case of a negative result, fitness can be maintained for a limited period, during which time further assessments are made.

(2) *Visual Standard 2 (VS/2)* [French initials: SVA/2]

This standard applies to the following:

- candidate pilots, all classes;
- candidate transport aircraft pilots;
- candidate navigators, bomb-aimers, radar operators;
- candidate air gunner observers.

(a) Visual acuity, measured *before* instillation of a cycloplegic, must be 9/10, correctable to 10/10, for each eye separately. *After* instillation of a cycloplegic, compulsory for all candidates, an objective refraction examination must show that total hypermetropia does not exceed 2 dioptres, that astigmatism is not more than 1 dioptre, and there is no myopia.

(b) The near point of accommodation must not differ from the values indicated in Visual Standard 1.

The near point of convergence must not be further than 8 centimetres.

(c) Heterophoria must meet the requirements of Visual Standard 1.

(d) The field of vision, at the periphery and in the centre, must be normal.

(e) Depth perception must be satisfactory.

(f) The night morphoscopic threshold must meet the requirements of Visual Standard 1.

(g) Intraocular tension must meet the requirements of Visual Standard 1.

(3) *Visual Standard 3 (VS/3)* [French initials: VSA/3]

This standard applies to the following:

- candidate navigators in transport aircraft;
- candidate military reserve pilots;
- pilots of jet fighter, reconnaissance and bomber aircraft;
- helicopter pilots;
- navigators, bomb-aimers, radar operators;
- air gunner observers;
- flight refuellers;
- candidate flying personnel of the light aviation of the Army and the Gendarmerie (with the exception of flight engineers).

(a) Visual acuity, *before* instillation of a cycloplegic, must be at least 8/10, correctable to 10/10, for each eye separately. *After* instillation of a cycloplegic, compulsory for all candidates, latent hypermetropia must not exceed 2.5 dioptries.

(b) The near point of accommodation, according to age, must not exceed by more than 4 centimetres the values quoted in Visual Standard 1.

The near point of convergence must not be further than 8 centimetres.

(c) Heterophoria must meet the requirements of Visual Standard 1.

(d) The field of vision, at the periphery and in the centre, must be normal.

(e) Depth perception must be satisfactory.

(f) The night morphoscopic threshold must meet the requirements of Visual Standard 1.

(g) Intraocular tension must meet the requirements of Visual Standard 1.

(4) *Visual Standard 4 (VS/4)* [French initials: SVA/4]

This standard applies to the following:

- candidate flight engineers;
- candidate female flight attendants;
- pilots of transport, bomber (conventional type) and twin-engined communications aircraft;
- pilots of liaison aircraft;
- pilots of single-engined light aircraft;
- military reserve pilots;
- ab initio flying training instructors;
- transport aircraft navigators;
- radio navigators.
- flying personnel of the light aviation of the Army and the Gendarmerie with the exception of flight engineers.

(a) Visual acuity must be at least 5/10, correctable to 10/10, for each eye separately. For subjects within this standard the wearing of corrective glasses is compulsory during flying. The use of contact lenses must be specifically authorised in each case after an objective examination for tolerance.

(b) the near point of accommodation, according to age, must not exceed by more than 4 centimetres the values quoted in Visual Standard 1.

The near point of convergence must not be more than 8 centimetres.

(c) Heterophoria must meet the requirements of Visual Standard 1.

(d) The field of vision, at the periphery and in the centre, must be normal.

(e) Depth perception must be satisfactory.

(f) The night morphoscopic threshold must not be more than 0.8 candle/square hectometre after 45 minutes' adaptation to complete darkness.

(g) Intraocular tension must meet the requirements of Visual Standard 1.

(5) *Visual Standard 5 (VS/5)* [French initials: SVA/5]

This standard applies to the following:

- air radio-operators;
- flight engineers (including those of the light aviation of the Army and the Gendarmerie);
- female flight attendants.

(a) Visual acuity must be at least 5/10 uncorrected by glasses, for each eye separately, or as a minimum, 3/10, correctable to 8/10, for any eye having a visual acuity of less than 5/10. For subjects within this standard the wearing of corrective glasses is compulsory during flying. The use of contact lenses must be specifically authorised in each case after an objective examination for tolerance.

(b) The near point of accommodation and the near point of convergence are not covered by any special requirements.

(c) Heterophoria is not covered by any special requirements.

(d) The field of vision, at the periphery and in the centre, must be normal.

(e) Binocular vision must be correct.

- (f) There are no special requirements in regard to the night morphoscopic threshold.
- (g) Intraocular tension must meet the requirements of Visual Standard 1.

2. *Federal Republic of Germany*

There are three classes of visual standards.

(1) *Visual Standard 1*

This standard applies to candidate aircraft pilots and to candidate helicopter pilots.

(a) Visual acuity, measured *before* instillation of a cycloplegic, must be at least 5/10, correctable to 10/10, for each eye separately. When corrective glasses are necessary in order to achieve 10/10, the wearing of glasses is compulsory during flying. A spare pair of glasses must be available. The use of contact lenses is not permitted.

Near vision, with or without corrective glasses, should permit the reading of Niden 1 at a distance of 25 to 30 cm.

After instillation of a cycloplegic, compulsory for all candidates, an objective refraction examination must show that the total hypermetropia does not exceed 2 dioptres, that astigmatism is not more than 1.0 dioptre in any meridian and myopia does not exceed 0.75 dioptre.

(b) The accommodative power must be such that reliable and continuous reading of instrument indications and flight data, even under stress conditions, can be anticipated after the age of 30.

The near point of convergence must not be more than 70 mm.

(c) Any esophoria of more than 10 prism dioptres, any exophoria of more than 5 prism dioptres, any hyperphoria or hypophoria of more than 1.5 prism dioptres is disqualifying.

In cases of heterophoria the reserve fusion amplitude must be at least 4 prism dioptres in the horizontal plane and at least 2 prism dioptres in the vertical plane.

Any paralytic or concomitant strabismus entails rejection.

(d) The field of vision, at the periphery and in the centre, must be satisfactory.

Any peripheral reduction due to anatomical malformation of the orbit or shape of the lids must not be more than 15%.

(e) Depth perception must be normal: the subject must read correctly at least 8 of the set of 10 stereograms presented to him.

(f) Retinal adaptation to glare must be normal.

In the event of an insufficient result from this test or in the event of findings indicative of a dark adaptation deficiency, the *night morphoscopic threshold* is determined. This should be normal, that is, it must lie within the 2 sigma standard curve.

(g) Intraocular tension is not measured routinely until the age of 40.

(2) *Visual Standard 2*

This standard applies to the following:

- aircraft pilots and student pilots;
- helicopter pilots;
- other aircrew members making flights in jet aircraft equipped with ejection seats.

(a) Visual acuity, measured *before* instillation of a cycloplegic, must be at least 3/10, correctable to 10/10, for each eye separately. When corrective glasses are required in order to achieve 10/10, the wearing of glasses is mandatory during flying. A spare pair of glasses must be available. The use of contact lenses is not permitted.

Near vision, with or without corrective glasses, must permit the reading of Niden 1 at a distance of 25 to 30 cm.

After instillation of a cycloplegic, an objective refraction examination must show that total hypermetropia does not exceed 4 dioptres, that astigmatism is not more than 2 dioptres in any meridian and that myopia does not exceed 1.5 dioptres.

(b) The accommodative power must meet the requirements of Visual Standard 1. The near point of convergence must meet the requirements of Visual Standard 1.

(c) The requirements relating to heterophoria and reserve fusion amplitude are similar to those in Visual Standard 1.

- (d) The requirements relating to the field of vision are similar to those in Visual Standard 1.
- (e) Depth perception must be normal. If the subject fails to name correctly at least 8 out of the 10 stereograms presented to him, he can still be passed fit for flying if the limitations in his depth perception are compensated by sufficient flying experience.
- (f) The morphoscopic threshold must be normal, that is, it must lie within the 2 sigma standard curve.
- (g) Intraocular tension must be normal. A routine test is carried out on all subjects over 40 years of age.

(3) *Visual Standard 3*

This standard applies to aircrew members other than pilots, with the exception of those listed under Visual Standard 2. It also applies to personnel required to perform flying duties occasionally but who are not involved in the control of the aircraft.

(a) Visual acuity, measured *before* instillation of a cycloplegic, does not have to meet any specified standard, but must be at least correctable to 10/10 for each eye separately. When corrective glasses are required in order to achieve 10/10, the wearing of glasses is mandatory during flying. A spare pair of glasses must be available. The use of contact lenses is not permitted.

Near vision, with or without corrective glasses, must permit the reading of Niden 1 at a distance of 25 to 30 cm.

After instillation of a cycloplegic, an objective refraction examination must show that total hypermetropia does not exceed 5.5 dioptries, that astigmatism is not more than 3.0 dioptries in any meridian and that myopia does not exceed 5.5 dioptries.

(b) The accommodative power must meet the requirements of Visual Standard 1. The near point of convergence must meet the requirements of Visual Standard 1.

(c) Heterophoria and reserve fusion amplitude are not measured. No requirement laid down in this connection.

(d) The requirements for the field of vision are the same as those of Visual Standard 1.

(e) Depth perception must satisfy the requirements of Visual Standard 2.

(f) The morphoscopic threshold must lie within the 3 sigma standard curve.

(g) The intraocular tension requirements are similar to those of Visual Standard 2.

3. *United Kingdom*

There are four separate visual standards.

(1) *Visual standards for the acceptance of candidate pilots*

(a) Visual acuity, measured *before* instillation of a cycloplegic, must be at least 6/9, correctable to 6/6, for each eye separately. If the examiner considers that flying spectacles with corrective glasses will be necessary at some future date, a decision on acceptance will be made by the Ministry of Defence, the final authority in such cases.

Near vision, with or without corrective glasses, should permit the reading of the N5 test type with each eye separately, at a distance appropriate to the age of the subject.

The objective refraction examination, without the use of a cycloplegic, should not reveal manifest hypermetropia of more than 2.25 dioptries.

After instillation of a cycloplegic, the spherical equivalent must remain between -0.25 and $+3.50$ dioptries in any meridian, but the astigmatism must not require more than 1 dioptr of cylinder.

(b) The near point of accommodation should correspond to the value for the appropriate age group, as shown in the following Table:

TABLE 6
Near Point of Accommodation in Relation to Age

<i>Age</i>	<i>Centimetres</i>
17 to 20	up to 10.9
21 to 25	11 to 12.4
26 to 30	12.5 to 13.9
31 to 35	14 to 15.9
36 to 40	16 to 18.4
41 to 45	18.5 to 26.9
46 and above	27 and above

The near point of convergence must not exceed 10 centimetres.

Cases of convergence insufficiency can be re-examined after a course of orthoptic exercises.

(c) Any esophoria of more than 6 prism dioptres, any exophoria of more than 8 prism dioptres or any hyperphoria or hypophoria greater than 1 prism dioptre, is a cause for rejection if the Maddox test is carried out at a distance of 6 metres. If the test is performed with the Maddox rod at 33 centimetres, the following limits must not be exceeded if the candidate is not to be disqualified: esophoria: 6 dioptres; exophoria: 16 dioptres; vertical phoria: 1 dioptre.

No candidate for training as a pilot who has asymptomatic heterophoria to a degree exceeding the fitness limits must be rejected without being subjected to a complete orthoptic examination and, if necessary, to an altitude chamber test. Such asymptomatic candidates can be accepted if the degree of fusion is within acceptable limits. Manifest strabismus is a cause for rejection.

(d) The visual field, at the periphery and in the centre, must be satisfactory. Deficiency of the visual field, particularly in the temporal region, entails rejection unless produced by a small quiescent lesion.

(e) Depth perception is not mentioned in the texts relating to fitness standards.

(f) The night morphoscopic threshold is not mentioned in the texts relating to fitness standards.

(g) Measurement of intraocular tension is not mentioned in the texts relating to fitness standards.

(2) *Visual standards for pilots*

(a) Visual acuity, measured *without* instillation of a cycloplegic, must be at least 0.5, correctable to 6/6, for each eye separately.

Near vision, with or without corrective glasses, must permit the reading of the N5 test type with each eye considered separately, at a distance appropriate to the age of the subject.

The objective refraction examination, without the use of a cycloplegic, should not reveal manifest hypermetropia of more than 2.25 dioptres.

Measurement of the refraction, *after* instillation of a cycloplegic, is not carried out at the periodic examinations, unless required by a clinical condition.

(b) Accommodation and convergence: requirements identical to those of the visual standard for the acceptance of candidate pilots (see (1), (b) above).

(c) Heterophoria: requirements identical to those of the visual standard for the acceptance of candidate pilots (see (1), (c) above).

(d) Field of vision: requirements identical to those of the visual standard for the acceptance of candidate pilots (see (1), (d) above).

(e) Depth of perception: not mentioned in the texts on fitness standards.

(f) Night morphoscopic threshold: not mentioned in the texts on fitness standards.

(g) Measurement of intraocular tension: not mentioned in the texts on fitness standards.

(3) *Visual standards for the acceptance of aircrew candidates, other than candidate pilots*

(a) Visual acuity, measured *before* instillation of a cycloplegic, must be at least 0.5, correctable to 6/6, for each eye considered separately.

Near vision, with or without corrective glasses, must permit the reading of the N5 test type with each eye separately, at a distance appropriate to the age of the subject.

The objective refraction examination, without the use of a cycloplegic, must not reveal any manifest hypermetropia of more than 2.25 dioptres.

After instillation of a cycloplegic, the spherical equivalent must remain between -0.75 and $+3.50$ dioptres in any meridian, but the astigmatism must not require more than 1 dioptre of cylinder.

(b) The near point of accommodation must correspond to the value appropriate to the age group (see Table under (1), (b) above).

The near point of convergence is not measured.

(c) No test for phoria is carried out, unless diplopia is present or there are other symptoms of ocular muscle imbalance. Unilateral manifest strabismus entails rejection, since the deviating eye will be amblyopic. Alternating strabismus, however, which is acceptable aesthetically, or which has been corrected surgically and does not impair visual acuity, may be accepted.

- (d) Field of vision: must meet the standards for candidate pilots (see (1), (d) above).
- (e) Depth perception: not mentioned in the texts relating to fitness standards.
- (f) Night morphoscopic threshold: not mentioned in the texts relating to fitness standards.
- (g) Measurement of intraocular tension: not mentioned in the texts relating to fitness standards.

(4) *Visual standards for flying personnel other than pilots*

- (a) Visual acuity, measured *before* instillation of a cycloplegic, must be at least 0.33, correctable to 6/6, for each eye considered separately.

Near vision, with or without corrective glasses, must permit the reading of the N5 test type with each eye separately, at a distance appropriate to the age of the subject.

The objective refraction examination, without the use of a cycloplegic, must not reveal any manifest hypermetropia of more than 2.25 dioptres.

Measurement of the refraction, after instillation of a cycloplegic, is not carried out at the periodic examinations, unless required by a clinical condition.

- (b) The other standards are similar to those applicable to aircrew candidates other than candidate pilots (see (3) above, (b), (c), (d), (e), (f), (g)).

(5) *The wearing of corrective glasses*

- (a) Pilots who need glasses to correct their distant vision must wear them continuously in order to reduce any changes in the size of objects and avoid disorientation effects.
- (b) Other flying personnel need not wear their glasses while flying unless this should prove necessary for the correct performance of their duties.
- (c) Contact lenses can be authorised only on the advice of the consultant ophthalmologist.

4. *Canada*

There are three visual standards.

(1) *Visual standard applicable to candidate pilots and to inexperienced pilots*

- (a) Visual acuity, measured *before* instillation of a cycloplegic, must be 6/6 in one eye and at least 6/9 in the other eye; the deficient eye need not be correctable to unity.

After instillation of a cycloplegic, the objective refraction examination must not reveal any total hypermetropia of more than 2.50 dioptres in any meridian. Simple myopia must be less than -0.25 dioptres in each eye.

In cases of astigmatism with hypermetropic component, the astigmatism indicated by the cylinder refractive power must not exceed +0.75 or -0.75 dioptre. If there is astigmatism with a myopic component, the astigmatism must not be more than the following combinations:

<i>Sphere</i>	<i>Cylinder</i>
0.25 dioptre	-0.25 dioptre
0.00 dioptre	-0.50 dioptre

- (b) Accommodation must be normal for the age of the subject. The near point of convergence must be at the normal distance.

- (c) Diplopia or a history of diplopia is a cause for rejection. If a candidate has undergone an operation on the orbital muscles, the medical examination must not take place until at least 3 months after the operation.

In the Maddox test at 6 metres, any esophoria or exophoria of more than 6 prism dioptres, or any hyperphoria of more than 1 prism dioptre is a cause for rejection.

In the Maddox rod test at 33 cm, any exophoria above the level of 12 prism dioptres is a cause for rejection.

- (d) The field of vision, at the periphery and in the centre, must be normal.

- (e) The results of various stereoscopic vision tests can be taken into consideration when assessing fitness, if the phoria tests gave doubtful or borderline results.

- (f) The night morphoscopic threshold is not mentioned in the statement of fitness standards.

- (g) Intraocular tension is not mentioned in the statement of fitness standards.

(2) *Visual standard applicable to experienced pilots, and also to candidates for aircrew duties, other than pilots*

- (a) Visual acuity, measured *before* instillation of a cycloplegic, must be at least 6/18, correctable to 6/6, for each eye separately, or at least 6/12 in one eye and 6/30 in the other eye, correctable to 6/6 for each eye considered separately.

After instillation of a cycloplegic, the objective refraction examination must not reveal any total hypermetropia of more than + 3.50 dioptres in any meridian, or any simple myopia of more than - 1 dioptre in each eye, or any hypermetropic astigmatism in which the astigmatism indicated by the cylinder corrective power exceeds + 1.25 dioptres or - 1.25 dioptres, or any myopic astigmatism the sphere and cylinder components of which are higher than the following values:

<i>Sphere component</i>	<i>Cylinder component</i>
- 1 dioptre	- 0.25 dioptre
- 0.75 dioptre	- 0.50 dioptre
- 0.50 dioptre	- 0.75 dioptre
- 0.25 dioptre	- 1 dioptre
- 0.00 dioptre	- 1.25 dioptres

Experienced pilots whose visual acuity is less than 6/18 and 6/18 or than 6/12 and 6/30 must be examined by an ophthalmologist. If the refractive error does not exceed - 1 spherical dioptre and is correctable to 6/6 in one eye, and at least 6/9 in the other eye, they will be passed as fit.

(b) Accommodation must be normal for the age group.

The near point of convergence must be at a normal distance.

(c) Diplopia or a history of diplopia is a cause for rejection. If a subject has undergone an operation on the orbital muscles, the medical examination must not take place until at least 3 months after the operation.

In the Maddox test at 6 metres, any esophoria or exophoria of more than 6 prism dioptres, or any hyperphoria of more than 1 prism dioptre, is a cause for rejection.

In the Maddox rod test at 33 cm, any exophoria of more than 12 prism dioptres is a cause for rejection.

Some degree of tolerance can, however, be assumed for experienced pilots or for candidates for aircrew duties other than those of a pilot. In doubtful cases, the subject is examined at the Defence and Civil Institute of Environmental Medicine.

(d) The field of vision, at the periphery and in the centre, must be satisfactory. Subjects with anomalies of the field of vision will be acceptable if the constriction is not due to progressive conditions.

If more detailed tests are necessary the case must be referred to the Central Medical Board at the Defence and Civil Institute of Environmental Medicine.

(e) The results of various stereoscopic vision tests may be taken into consideration when assessing fitness, if the phoria tests gave doubtful or borderline results.

(f) The night morphoscopic threshold is not mentioned in the statement of fitness standards.

(g) Intraocular tension is not mentioned in the statement of fitness standards.

(3) *Visual standard applicable to experienced flying personnel other than pilots*

(a) Visual acuity, measured *before* instillation of a cycloplegic, must be at least 6/60, corrected to 6/9, for each eye considered separately.

After instillation of a cycloplegic, the objective examination must not reveal any total hypermetropia of more than + 3.50 dioptres in any meridian, any simple myopia of more than - 2 dioptres in each eye, any hypermetropic astigmatism in which the astigmatism indicated by the cylinder corrective power exceeds + 1.25 dioptres or - 1.25 dioptres, or any myopic astigmatism the sphere and cylinder components of which are higher than the following values:

<i>Sphere component</i>	<i>Cylinder component</i>
- 1 dioptre	- 0.25 dioptre
- 0.75 dioptre	- 0.50 dioptre
- 0.50 dioptre	- 0.75 dioptre
- 0.25 dioptre	- 1 dioptre
- 0.00 dioptre	- 1.25 dioptres

(b) Accommodation must be normal for the age group.

The near point of convergence must be at a normal distance.

(c) Diplopia or a history of diplopia is a cause for rejection. If a subject has undergone an operation on the orbital muscles, the medical examination must not take place until at least 3 months after the operation.

In the Maddox test at 6 metres, any esophoria or exophoria of more than 6 prism dioptres, or any hyperphoria of more than 1 prism dioptre is a cause for rejection.

In the Maddox rod test at 33 cm, any exophoria of more than 12 prism dioptres is a cause for rejection.

Some degree of tolerance, may, however, be allowed for subjects performing flying duties other than those of a pilot. In cases of doubt, the subject is examined at the Defence and Civil Institute of Environmental Medicine.

- (d) The field of vision, at the periphery and in the centre, must be satisfactory.
- (e) The results of various stereoscopic vision tests may be taken into consideration when assessing fitness, if the phoria tests gave doubtful or borderline results.
- (f) The night morphoscopic threshold is not mentioned in the statement of fitness standards.
- (g) Intraocular tension is not mentioned in the statement of fitness standards.

5. Belgium

There are five visual standards.

(1) *Visual standard applicable to candidate pilots or candidate navigators, and to student pilots and student navigators undergoing training*

(a) *Distant vision*

When measured by means of the Snellen optometric scale at a distance of 6 metres, visual acuity must be 6/6 in each eye considered separately, without corrective glasses, or contact lenses or other types of glasses.

However, for candidates for training as pilots of Army single engined light aircraft, visual acuity must be at least 8/10, correctable to 10/10, in each eye considered separately.

For near vision, Jaeger 1 must be read at a distance of 50 cm for each eye separately, without corrective glasses of any kind.

Any refractive error, determined as necessary under cycloplegia, must not exceed the following limits:

1. *Hypermetropia*: 2.25 dioptres in one eye or in both eyes.
2. *Myopia*: no degree of myopia will be acceptable.
3. *Astigmatism*: 0.75 dioptre in one eye or in both eyes; refraction in any meridian must not exceed 2.5 dioptres.
4. *Anisometropia*: 1 dioptre

(b) *Accommodation*

Taking age and the degree of refraction into account, accommodation must not be less than the limits stated below:

TABLE 7

Accommodation in Relation to Age

Age in years	Dioptres	Age in years	Dioptres
17	8.8	31	5.4
18	8.6	32	5.1
19	8.4	33	4.9
20	8.1	34	4.6
21	7.9	35	4.3
22	7.7	36	4.0
23	7.5	37	3.7
24	7.2	38	3.4
25	6.9	39	3.1
26	6.7	40	2.8
27	6.5	41	2.4
28	6.2	42	2.0
29	6.0	43	1.5
30	5.7	44	1.0
		45	0.6

Power of convergence: The near point of convergence must not be further than 75 mm, except for the candidate pilot of Army light aviation aircraft, when it must not exceed 100 mm.

(c) *Orbital muscle balance*

1. Heterophoria, measured at 6 metres using the Maddox phorometer, must not exceed the following maximum values for candidates for training as pilots and for student pilots:

hyperphoria:	1 prism dioptre
esophoria:	8 prism dioptres
exophoria:	6 prism dioptres

A higher degree of heterophoria is acceptable in candidates for training as navigators.

2. Prism divergence at 6 metres must not be less than 2 dioptres or more than 15 dioptres.

3. Binocular fixation: there must be no deviation of binocular vision greater than 25 degrees, that is, no deviation is acceptable within a circle of 50 cm radius around a point situated 75 cm in front of the eyes of the subject being examined.

(d) *Visual fields*

The visual fields must be normal for each eye considered separately. A reduction of more than 15° as compared with the following limits will not be acceptable: temporally 90°; nasally 65°; superiorly 55°; inferiorly 70°. There must be no scotoma.

(e) *Depth perception* is tested by means of stereograms.

No account is, however, taken of the results of this test when assessing fitness from the point of view of the visual function. The results of this test, as mentioned earlier, are integrated in a series of psychosensory and psychomotor tests the overall results of which provide an assessment of candidates' chances of success at the elementary flying training School.

(f) *The night morphoscopic threshold and the ability of the retina to adapt to darkness* must be normal for the flying personnel who have to carry out or are likely to carry out flying duties at night. The pathological absence of night vision will be determined by special tests.

(g) *Intraocular tension* must be normal.

(2) *Visual standard applicable to candidates for training as flight engineers or radio operators and to personnel authorised to carry out flying duties from time to time, but who are not involved in the control of the aircraft*

(a) With regard to candidates for training as flight engineers or radio-operators, *visual acuity*, measured by means of the Snellen optometric scale at a distance of 6 metres, must be at least 0.4 without correction, for each eye separately, provided it can be increased to 6/6 in each eye by means of corrective glasses. For *near vision*, Jaeger 1 must be read at 50 cm for each eye considered separately, without corrective glasses of any kind.

No account is taken of *refraction standards*.

(b) *Accommodation and convergence*: the same standard as for candidates for training as pilots.

(c) *Heterophoria*: No standards laid down.

(d) *Visual fields*: the same visual standard as for candidates for training as pilots.

(e) *Depth perception*: this is not tested.

(f) *Night morphoscopic threshold*: this is not tested.

(g) *Intraocular tension*: must be normal.

With regard to personnel authorised to carry out flying duties from time to time, the same standards are applicable, except visual acuity at a distance of 6 metres, which must be at least 0.1 without correction, in each eye, and correctable to 6/6.

(3) *Visual standard applicable to combat aircraft pilot and to combat aircraft navigator*

(a) *Visual acuity*

An acuity of 0.7 in each eye is acceptable for flying, on condition that it can be brought up to 6/6 by means of corrective glasses and that there is no pathological anomaly present or likely in the future to cause subsequent further impairment. Only those pilots who have had at least 10 years' flying experience and completed 1000 hours on operational aircraft may be retained if their visual acuity is at least 0.5 in one eye or in both eyes, provided that it can be brought up to 6/6 by means of corrective glasses, that there is no pathological anomaly present or likely in the future to cause further impairment and that corrective glasses can be worn continuously during the exercise of their duties as pilots.

The standards for *near vision* are the same as those for candidates for training as pilots.

Refraction: refraction standards no longer apply at the periodic examinations.

(b) *Accommodation*

This must be normal, as appropriate to the age of the subject. (See Table quoted under (1), (b) above.) A convergence power of up to and including 12 cm is acceptable.

(c) *Heterophoria*

In pilots with at least 10 years' flying experience 6 prism dioptres of exophoria or 10 prism dioptres of esophoria or 1 prism dioptre of hyperphoria may be permitted, the test being made at a distance of 6 metres, using the Maddox phorometer.

(d) *Visual fields*

The visual standard for candidates for training as pilots is applied.

(e) *Depth perception*

This is not tested.

(f) *Night morphoscopic threshold*

The visual standard for candidates for training as pilots is used.

(g) *Intraocular tension*

This must be normal.

(4) *Visual standard applicable to pilots of military transport aircraft, training aircraft, communications aircraft and helicopters*(a) *Distant vision*

Visual acuity must be at least 0.7, for each eye considered separately and without corrective glasses.

However, if the visual acuity in one or in both eyes is less than 0.7, but not less than 0.3 and can, by means of corrective glasses, be increased to 6/6 or more, for each eye, the subject may be declared fit for employment as pilot of a military transport aircraft or as pilot of a training aircraft, a communications aircraft or a helicopter. Any pilot of a military transport aircraft, or any pilot of a training or communications aircraft, or of a helicopter, with a visual acuity of less than 0.7 must wear corrective glasses continuously while carrying out his duties as pilot.

For *near vision*, the standards are the same as those for candidates for training as pilots.

Refraction: refraction standards no longer apply at the periodic examinations.

(b) *Accommodation*

This must be normal, as appropriate to the age of the subject (see the Table quoted under (1), (b) above).

A *convergence* power of up to and including 12 cm is acceptable.

(c) *Heterophoria*

In pilots who have had at least 10 years' flying experience 6 prism dioptres of exophoria or 10 prism dioptres of esophoria or 1 prism dioptre of hyperphoria may be permitted, the test being made at a distance of 6 metres, using a Maddox phorometer.

(d) *Visual fields*

The visual standard for candidates for training as pilots is applied.

(e) *Depth perception*

This is not tested.

(f) *Night morphoscopic threshold*

The visual standard for candidates for training as pilots is used.

(g) *Intraocular tension*

This must be normal.

(5) *Visual standard applicable to navigators in military transport aircraft, radio operators in military transport aircraft and crew technicians*(a) *Distant vision*

Visual acuity must be at least 0.5, uncorrected vision, for each eye separately. However, if visual acuity in one or both eyes is less than 0.5 but not below 0.3, and is correctable, by means of glasses, to 0.7 or better for each eye, the subject may be declared fit, on condition that corrective glasses are worn when he is performing the duties of navigator in a military transport aircraft, radio operator in a military transport aircraft, or crew technician.

For *near vision*, the standards are the same as those for candidates for training as pilots.

Refraction: refraction standards are no longer applicable at periodic examinations.

(b) *Accommodation*

This must be normal in relation to age (see Table quoted under (1), (b) above).

A convergence power of up to and including 12 cm is acceptable.

(c) *Heterophoria*

The heterophoria standards do not apply to the above categories of flying personnel.

(d) *Visual field*

The same visual standard as for candidates for training as pilots is used.

(e) *Depth perception*

It is not tested.

(f) *Night morphoscopic threshold*

This is not tested.

(g) *Intraocular tension*

It must be normal.

(6) *Exceptional provisions applicable only to pilots*

(a) Standards lower than those listed above may be applied in exceptional cases on the recommendation of the Chief of Staff of the armed force concerned and solely in the case of experienced pilots flying in aircraft in which control of the aircraft can be entrusted to another experienced pilot present at the time, without reducing flight safety,

(b) Pilots who have lost the complete or partial use of one eye as a result of eye injuries sustained during air operations in time of war may be permitted to continue flying:

1. as pilots, but with restrictions in regard to the type of aircraft and the nature of the operations (all combat operations being excluded), and on condition that the healthy eye has a visual acuity of 6/6.
2. as navigators or radio operators, on the same conditions as above.

6. *USAF*

Three standards are taken into consideration.

(1) *Visual standard applicable to candidates for training as pilots (Flying Class I) and candidates for training as navigators (Flying Class I and Ia)*(a) *Visual acuity*

Distant visual acuity must be 20/20 in each eye, without correction by glasses, in the case of candidates for training as pilots or as navigators (Flying Class I).

Under a special provision for Class Ia, candidates for aircrew duties who do not meet the visual or sitting height standards for Class I may be accepted as navigators, if visual acuity is at least 20/70 in each eye and if it can be corrected to 20/20 by the wearing of glasses.

Near vision must be 20/20 in each eye without corrective glasses.

Refraction must meet the following standards:

1. *Refraction in candidates for training as pilots (Flying Class I)*
 - (a) The refractive error must not be more than +1.75 or -0.25 dioptre in any meridian.
 - (b) Astigmatism must not exceed 0.75 dioptre.
 - (c) The use of contact lenses is not acceptable.
2. *Refraction in candidates for training as navigators (Flying Class Ia)*
 - (a) The refractive error must not be more than +3.00 dioptres or -1.50 dioptres in any meridian.
 - (b) Astigmatism must not exceed 2.00 dioptres.
 - (c) The use of contact lenses is not acceptable.

(b) *Accommodation*

The minimum acceptable value for accommodative power must not be less, in relation to age, than that indicated in a Table, which is identical with that quoted above in the Belgian regulations.

Convergence: the near point of convergence must not be more than 7 centimetres.

(c) *Heterophoria and heterotropia*

Esophoria greater than 10 prism dioptres, exophoria greater than 5 prism dioptres, hyperphoria greater than 1.5 prism dioptres, and heterotropia are causes for disqualification.

Binocular fixation: During the red lens test any diplopia or suppression of binocular fixation within a circle of 20 inches radius around a point situated 75 cm in front of the subject's eyes is not acceptable. Failure to pass this test, in the absence of other eye deficiencies or disorders is not necessarily disqualifying. However, failure of this test should be cause for a complete evaluation of ocular mobility and motility by a qualified ophthalmologist, with an opinion as to the reason for the failure.

(d) *Visual fields*

The visual fields should be normal for each eye separately. A contraction in either eye of 15° or more in any meridian is disqualifying. Scotoma, other than physiological scotoma, is also disqualifying.

(e) *Depth perception*

1. If the VTA-ND (Vision Test Apparatus-Near Distant) is used, an error in Groups B, C or D is disqualifying.
2. If the Verhoeff Depth Perception Apparatus (DPA-V) is used, any error in eight presentations during the first test and any error during a second or third test, if required, is disqualifying.
3. If the Howard-Dorman apparatus (DPA-HD) is used, any average error greater than 30 mm is disqualifying.

(f) *Night morphoscopic threshold*

This must be normal. A deficiency of this threshold, as demonstrated by history and confirmed by the test described above in (1) of this Chapter relating to examination techniques and testing equipment entails rejection.

(g) *Intraocular tension*

It must be normal.

Glaucoma, as evidenced by tension above 30 mm Hg, or by associated secondary changes in the optic disc or the visual field is a cause for rejection.

Preglaucoma, as evidenced by at least two determinations of a tension of 22 mm Hg or higher, or a difference of more than 4 mm Hg between the tension in both eyes, entails rejection.

(2) *Visual standard applicable to qualified flying personnel – pilot or navigator (Flying Class II)*

(a) *Visual acuity*

Distant visual acuity must be at least 20/200, correctable to 20/20 by glasses, for each eye considered separately.

Near vision must be at least 20/200, correctable to 20/20, for each eye considered separately.

Refraction

1. The refractive error must not be greater than +5.50 or -5.50 dioptres in any meridian.
2. Astigmatism must not exceed 3.00 dioptres.
3. Anisometropia must not exceed 3.50 dioptres.
4. Complex refractive defects which can be corrected only by contact lenses are causes for rejection. The use of contact lenses is always a cause for disqualification.

(b) *Accommodation*

This is related to age (see Table quoted above in the Belgian regulations).

The near point of *convergence* must not be more than 7 centimetres.

(c) *Heterophoria and heterotropia*

Esophoria greater than 10 prism dioptres, exophoria greater than 5 prism dioptres, hyperphoria greater than 1.5 prism dioptres and the presence of heterotropia are causes for disqualification.

The binocular fixation (red lens) test is not performed.

(d) *Visual fields*

The visual fields must be normal for each eye separately.

A contraction in either or in both eyes of 15° or more in any meridian is disqualifying.

Scotoma due to an active pathological process is disqualifying.

Scotoma resulting from a healed lesion is a cause for rejection unless it is the opinion of the examiner that it will not compromise flying efficiency or the well-being of the subject.

(e) *Depth perception*

This must be normal. The same standards apply as for candidates for training as pilots (Flying Class I) or as navigators (Flying Class Ia).

(f) *Night morphoscopic threshold*

This must be normal. The same standards apply as for candidates for training as pilots (Flying Class I) or as navigators (Flying Class Ia).

(g) *Intraocular tension*

Glaucoma and preglaucoma are causes for rejection. These conditions are determined by applying the same standards as those quoted above for candidates for training as pilots (Flying Class I) or as navigators (Flying Class Ia).

- (3) *Visual standard applicable to personnel who perform flying duties as and when the need arises, but who are not involved in the control of the aircraft (medical officer, nurses etc.) (Flying Class III)*

(a) *Visual acuity*

Uncorrected distant visual acuity must be at least 20/400 in each eye, and be correctable to at least 20/20 in one eye, and to at least 20/30 in the other eye by the use of glasses.

Near vision must be 20/20 in one eye, if necessary with corrective glasses, and at least 20/30 in the other eye, if necessary with corrective glasses.

Refraction must be within the limits laid down above for trained pilots and navigators (Flying Class II).

(b) *Accommodation*

No standard.

Convergence: no standard.

(c) *Heterophoria and heterotropia*

Esophoria greater than 15 prism dioptres, exophoria greater than 8 prism dioptres, hyperphoria greater than 2 prism dioptres or the presence of heterotropia are causes for rejection.

The binocular fixation (red lens) test is not performed.

(d) *Visual fields*

The visual fields must be normal for each eye separately. The standards laid down for fully trained pilots and navigators (Flying Class II) are applicable.

(e) *Depth perception*

No standard applied.

(f) *Night morphoscopic threshold*

This must be normal.

The same standards are applied as those laid down above for candidates for training as pilots (Flying Class I) or as navigators (Flying Class Ia).

(g) *Intraocular tension*

This must be normal. Glaucoma and preglaucoma entail rejection. The same standards are applied as those quoted above for candidates for training as pilots (Flying Class I) or as navigators (Flying Class Ia).

7. *US Navy*

Two standards are taken into consideration.

- (1) *Visual standard applicable to candidates for training as pilots or as navigators*

This standard is very similar to that of the USAF for candidates for training as pilots. A few differences should, however, be noted, particularly in regard to the refraction and exophoria standards.

(a) *Visual acuity*

Distant visual acuity, without the wearing of corrective glasses, must be 20/20 in each eye.

Near vision must be equal to 6/6 in each eye.

With regard to *refraction* standards, after instillation of a cycloplegic, the candidate must be able to read 20/20 in each eye with:

1. total myopia not exceeding -0.25 dioptres in any meridian;
2. total hypermetropia not exceeding $+2.50$ dioptres in any meridian;
3. astigmatism not exceeding $+0.75$ dioptre. The correction for astigmatism must be noted in terms of the positive cylinder required.

(b) *Accommodation*

The minimum acceptable value of the accommodative power must not be less, according to the age of the subject, than that given in a table, which is identical with that quoted above in the Belgian regulations.

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The near point of *convergence* must not be more than 7 centimetres.

(c) *Heterophoria and heterotropia*

Measurement of the phorias performed at 20 feet: esophoria greater than 10 prism dioptres, exophoria greater than 10 prism dioptres, hyperphoria greater than 1 prism dioptre and the presence of heterotropia are causes for rejection.

Prism divergence determined at 20 feet: each dioptre of esophoria within the 10 dioptre maximum must be compensated by an equal or greater amount of prism divergence at 20 feet. If measured at 13 inches, a prism divergence of less than 12 dioptres is disqualifying.

Binocular fixation: in the red lens test, any diplopia or suppression of binocular fixation is not acceptable within a circle of 50 centimetres radius around a point situated 75 centimetres from the eyes of the subject.

(d) *Visual fields*

The visual fields must be normal for each eye considered separately.

A contraction in one or in both eyes of 15° or more in any meridian is disqualifying. The normal limits of the visual field are as follows:

temporally	90°
supero-temporally	62°
superiorly	52°
supero-nasally	60°
infero-nasally	55°
inferiorly	70°
infero-temporally.....	85°

It will be noted that these limits are different from those given in the Belgian regulations.

Scotoma, other than physiological scotoma, is disqualifying.

(e) *Depth perception*

1. If the AFVT apparatus is used (Armed Forces Vision Tester, similar to the VTA-ND of the USAF), an error in Groups B, C or D is disqualifying.
2. If the Verhoeff apparatus is used, any error in reading the 8 presentations in two of the three series of tests is disqualifying.
3. No mention is made of the Howard-Dolman apparatus.

(f) *Night morphoscopic threshold*

There are no requirements for measurement of this threshold in the text relating to the standards to be met at the initial examination.

(g) *Intraocular tension*

Glaucoma or preglaucoma is disqualifying.

Any reading from a Schiøtz tonometer which is consistently above 25 mm Hg for one or both eyes, or a difference in tension of 5 mm Hg between both eyes must be referred for advice to an ophthalmologist in the nearest military hospital.

(2) *Visual standards applicable to fully trained pilot or navigator*

Consideration will be restricted to the main standards which should be compared with those given in other regulations. The requirements covering very specific or very limited categories will not be discussed here, being of insufficient importance for inclusion in a comparative study of this kind.

The following will be considered in turn:

- i. *Visual standard for Service Group I:* Applies to aviators under 45 years of age who meet the general physical standards for Service Group I and are qualified for flying duties of an unlimited or unrestricted nature.
- ii. *Visual standard for Service Group II:* Applies to aviators under 45 years of age who meet the physical standards for Group II, and to aviators in Group I who, temporarily unfit for service under Group I, still meet the physical requirements for Group II. These aviators are suitable for flying duties, but are barred from air operations from carriers, except carrier-based helicopter missions.
- iii. *Visual standard for Service Group III:* Applies to aviators 45 years of age and over who meet the physical standards of Groups I, II or III, and aviators under 45 years of age who are recovering from an illness or an injury, and meet the standards of Group III, but are not physically qualified for the other Service Groups, when the needs of the service and the flying experience of the subjects justify their employment in such a limited status.

Service Group III aviators normally fly only aircraft equipped with dual controls and must be accompanied on all flights by a pilot or co-pilot of Service Group I or II qualified to fly the aircraft type operated.

With the agreement of the Deputy Chief of Naval Operation (Air), or the Commandant of the Marine Corps, as appropriate, aviators in Service Group III who meet the physical standards for Service Groups I or II may fly alone in aircraft which correspond with their individual physical and service qualifications.

i. *Visual standard for Service Group I*

(a) *Visual acuity*

Visual acuity must be 20/50 in each eye, correctable to 20/20 in each eye by means of glasses. When the visual acuity of one or both eyes is less than 20/30, each eye must be capable of becoming 20/20 by means of corrective glasses, which must be worn at all times while flying. The corrective lenses must be mounted in aviation frames, corrective sunglasses may be prescribed.

The wearing of contact lenses is prohibited.

Near vision must be 6/6 in each eye.

Refraction: Refraction must be measured at the periodic examinations whenever visual acuity in one or in both eyes is found to be not more than 20/30, and subsequently in the event of a further reduction in visual acuity being noted.

The examination is conducted after instillation of a cycloplegic, and the subject is disqualified if an acuity of 20/20 cannot be achieved in each eye after correction, or if a correction of more than -1.25 dioptres in any meridian (sphere and cylinder correction combined) is required.

The wearing of contact lenses is prohibited.

(b) *Accommodation*

The minimum acceptable value for the accommodative power must not be less, in relation to age, than that indicated in a table which is identical to that quoted above in the Belgian regulations.

The near point of *convergence* must not be more than 7 centimetres.

(c) *Heterophoria and heterotropia*

Esophoria greater than 10 prism dioptres, exophoria greater than 10 prism dioptres, hyperphoria greater than 1.5 prism dioptres, or any evidence of heterotropia are causes for rejection.

Measurement of prism divergence at 20 feet and 13 inches is optional at periodic examinations.

It is performed only on aviators who have suffered significant head injury, central nervous system disease or who have demonstrated a change in the value of the phorias observed previously.

Binocular fixation: The red lens test is conducted only if indicated. Diplopia or suppression of binocular fixation is not acceptable within a circle of 50 centimetres radius around a point situated 75 centimetres from the eyes of the subject.

(d) *Visual fields*

The standards are the same as those for candidates for training as pilots.

(e) *Depth perception*

The standards are the same as those for candidates for training as pilots.

(f) *Night morphoscopic threshold*

No requirement for measurement of this threshold appears in the text covering the standards to be met at the fitness examination for this category.

(g) *Intraocular tension*

The standards are the same as those for candidates for training as pilots. Intraocular tension must be determined at each medical fitness examination by digital palpation or by means of the Schiotz tonometer. Tonometric measurements will always be made from the age of 35 years onwards.

ii. *Visual standard for Service Group II*

This visual standard is the same as for Service Group I, except for the following provisions relating to visual acuity, refraction, accommodation and depth perception.

(a) *Visual acuity*

Visual acuity must be at least 20/100 in each eye. When the visual acuity of one or of both eyes is less than 20/30, each eye must be capable of an acuity of 20/20 by means of corrective glasses, which must be worn at all times while flying.

No refractive limits are required.

(b) *Accommodation*

When glasses are required in order to correct visual acuity to 20/20, they must be worn during the accommodation test, which must be performed on both eyes.

When accommodation under these conditions is less than 2.5 dioptres, it must be corrected by sufficient addition to obtain 2.5 dioptres of accommodation. This correction must be available at all times while flying.

(c) *Depth perception and distant vision*

When any correction is required for depth perception, the corrective glasses must be available at all times while flying.

iii. *Visual standard for Service Group III*

This standard is the same as for Service Group II, except for the following requirements relating to visual acuity and heterophoria.

(a) *Visual acuity*

Visual acuity must be at least 20/200 in each eye. When visual acuity in one or in both eyes is less than 20/30, each eye must be capable of an acuity of 20/20 by means of corrective glasses, which must be worn at all times when flying.

(b) *Heterophoria*

There must be no eye muscle imbalance, that is, phoria of sufficient degree to result in diplopia, during the red lens test, within a circle of 50 centimetres radius around a point situated 75 centimetres in front of the subject's eyes.

iv. *Visual standard applicable to Naval Flight Surgeons, Aviation Medical Examiners, Aviation Physiologists, Aviation Experimental Psychologists*

For the purpose of carrying out their duties under orders, while flying, but not in control of the aircraft, naval flight surgeons, aviation medical examiners, aviation physiologists and aviation experimental psychologists must meet the medical standards of the appropriate Service Group according to their age in Class I, except for visual acuity, which is the same as that required for Staff Officers of the general services.

Students in the above-mentioned categories of medical personnel must meet the standards laid down for flight surgeons, but visual acuity must be not worse than 20/100 in each eye, correctable to 20/20 in each eye.

Only those officers who meet the physical standards of Class I, Service Group I are qualified to fly solo in elementary aircraft. Although they may fail to meet the visual standards required for flying solo, they may, however, be given training enabling them to fly as a special crew member, and leading to their appointment as flight surgeons, aviation physiologists and aviation experimental psychologists.

8. *US Army*

Four standards are considered:

(1) *Visual standard applicable to candidates for training as Army flying personnel (Flying Class I)*

This is the same as the USAF visual standard for candidates for training as pilots (USAF Flying Class I).

(2) *Visual standard applicable to candidates for training as Army flying personnel under the grading Flying Class Ia*

This applies to the following:

- i. individuals chosen as candidates for training as Army flying personnel, only in accordance with special directives by the Department of the Army;
- ii. individuals already selected for training, before their flying training has begun.

(a) *Visual acuity*

Distant visual acuity must be at least 20/50 in each eye without corrective glasses, and correctable to 20/20 with glasses.

With regard to *near visual acuity*, for individuals under 35 years of age, this must be 20/20, uncorrected, in each eye considered separately. In individuals over 35 it must be at least 20/50 in each eye, without correction, and correctable with glasses to 20/20 in each eye.

Refraction: Astigmatism must not be greater than 0.75 dioptre.

Hypermetropia must not exceed 1.75 dioptres in any meridian in subjects under 35, or 2.00 dioptres in any meridian in subjects aged 35 or over.

Myopia must not be greater than 0.75 dioptre in any meridian.

All the other standards are the same as those for the USAF Flying Class I.

(3) *Visual standard applicable to serving flying personnel (Flying Class 2)*

This visual standard is the same as for Flying Class I, except as listed below:

(a) *Visual acuity*

Uncorrected *distant visual acuity* must be at least 20/100 in each eye, and correctable by glasses to 20/20 in each eye.

Uncorrected *near visual acuity* should be at least 20/100 in each eye, correctable by glasses to 20/20 in each eye.

No *refractive* standard is applied.

(b) *Heterophoria and heterotropia*

Hyperphoria must not be greater than 1.5 prism dioptre. If a subject fails to pass the red lens test he must be referred to a qualified ophthalmologist, before a final decision is given by the Surgeon General.

(c) *Visual fields*

There must be no scotoma, other than physiological scotoma, unless the pathological process has healed and will in no way interfere with the flying efficiency or the well-being of the individual.

(4) *Visual standard applicable to personnel who perform flying duties as and when the need arises, but who are not involved in the control of the aircraft (medical officers, observers, mechanics etc.) – (Flying Class III)*

The standards are the same as for flying Class II, except for the following point:

Distant visual acuity: This must be at least 20/200 uncorrected in each eye and must be correctable with glasses to 20/20 in each eye.

(c) *Conclusions*

Eyesight standards have always been the most important cause for rejection among candidates for training as military aircrew. The reduction of visual capacity with age is also a source of difficulty for a great number of pilots throughout their career.

It is a well known fact that medical fitness standards are not solely related to problems of flying training ability, efficient performance of flying duties, flight safety, protection of the pilot against the harmful elements in flying and ability to withstand such elements.

Problems of another kind, such as the recruitment of a sufficient number of candidates so that supply can meet demand – a factor which is itself dependent on a general military policy – lend a certain weight, varying according to circumstances, to the strictness of some of the standards. This is certainly true in the case of the eyesight standards, since they are responsible for the highest rate of disqualification.

While exercising a certain amount of care when interpreting the data, it would appear very helpful to compare the eyesight standards laid down in the various regulations under consideration. The comparison will be confined to the three major categories which offer the greatest opportunity for a comparison devoid of secondary considerations of an administrative nature: the candidate for training as a pilot, all classes; the combat aircraft pilot (jet fighter, reconnaissance, bomber) and the transport aircraft pilot.

An examination of the various factors involved in the visual function will reveal, in each of these three categories, the profound differences which sometimes separate the various regulations, though without its being possible to explain – on purely medical grounds – the reasons or the justifications for such a disagreement.

The comparative Tables 11, 12 and 13 are extremely significant in this respect.

1. *Candidates for Training as Pilots – All Classes*

(a) *Visual acuity*

Visual acuity, measured at 6 metres (20 feet) before instillation of a cycloplegic, is not covered by the same requirements in all the Air Forces. The various standards are listed in the Table overleaf (Table 8).

If we exclude the very special provisions specific to Class Ia in the US Army, which cannot be included in this comparative study relating to candidates for training as pilots – all categories, it will be seen that:

- of the 9 regulations studied, 5 require 10/10 for each eye separately, uncorrected by glasses;
- the others require a visual acuity of less than 10/10, without glasses, to be correctable to 10/10 in each eye by means of glasses;
- the lowest visual acuity, uncorrected, is 5/10 in each eye. However, this standard exists in only one country (Germany).

TABLE 8

Visual Acuity Required in the Various Air Forces

<i>Air Force</i>	<i>Vision without corrective glasses</i>		<i>Requirement for correction by glasses to</i>	
Belgium	$\frac{6}{6}$	$\frac{6}{6}$	—	—
Norway	$\frac{6}{6}$	$\frac{6}{6}$	—	—
USAF (1)	$\frac{20}{20}$	$\frac{20}{20}$	—	—
US Navy	$\frac{20}{20}$	$\frac{20}{20}$	—	—
US Army (2)	$\frac{20}{20}$	$\frac{20}{20}$	—	—
France	$\frac{9}{10}$	$\frac{9}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
Canada	$\frac{6}{6}$	$\frac{6}{9}$	—	—
United Kingdom	$\frac{6}{9}$	$\frac{6}{9}$	$\frac{10}{10}$	$\frac{10}{10}$
Federal Republic of Germany	$\frac{5}{10}$	$\frac{5}{10}$	$\frac{10}{10}$	$\frac{10}{10}$

Notes

- (1) For Class IA in the USAF, visual acuity in each eye must be at least 20/70, correctable to 20/20. This refers to candidates for training as navigators and not as pilots.
- (2) For Class IA in the US Army, covering a special recruitment of flying personnel for the Army Aviation, visual acuity in each eye must be at least 20/50, correctable to 20/20.

Near vision, which is not covered by explicit standards in all the regulations, must also, when it is mentioned, be equal to 10/10 in each eye, most frequently without corrective glasses.

The requirements for the objective *refraction* examination, *after* instillation of a cycloplegic, vary widely in the standards considered to be compatible with an assessment of fitness at the initial examination.

The following Table (Table 9), which summarises these standards, lists the various Air Forces in the same order as in Table 8 relating to distant visual acuity.

TABLE 9

Comparative Table of the Refractive Error Requirements

<i>Air Force</i>	<i>Maximum permissible hypermetropia in dioptries</i>	<i>Maximum permissible astigmatism in dioptries</i>	<i>Maximum permissible myopia in dioptries</i>
Belgium	2.25	1.75	0
Norway	1.75	0.75	0.25
USAF	1.75	0.75	0.25
US Navy	2.50	0.75	0.25
US Army	1.75	0.75	0.75
France	2.00	1.00	0
Canada	2.50	0.75	0.25
United Kingdom	2.25	1.00	0.25
Federal Republic of Germany	2.00	1.00	0.75

- (b) The maximum values not to be exceeded for the near point of *accommodation* are fixed according to the age of the subject.

Differences exist in the values quoted in the regulations which give a Table of numerical values for these limits, either in dioptres or in centimetres. Other regulations contain only general statements, and give no numerical values. Very precise valid comparisons are therefore impossible.

The maximum permissible distance for the near point of *convergence* also reveals requirements which do not show a great deal of uniformity:

France	80 millimetres
Federal Republic of Germany...	70 millimetres
United Kingdom	100 millimetres
Canada	normal distance (figures not quoted)
Belgium	75 millimetres
Norway	70 millimetres
USAF	70 millimetres
US Navy	70 millimetres
US Army	70 millimetres

- (c) *Heterophoria and heterotropia*

Heterotropia is disqualifying in all the regulations. The heterophoria limits (measured at 6 metres) considered to be still compatible with fitness likewise reveal marked variations. Even so, it should be added that, under the French, British and German regulations, any exceeding of these limits will not entail the rejection of the candidate for training as a pilot if an orthoptic examination shows a satisfactory fusion amplitude and if a low pressure chamber test at an altitude of 3,500 metres for 20 minutes does not result in any objective diplopia. It is self-evident that the scientific and practical significance of the numerical values fixed for the heterophoria limits is consequently somewhat unreliable.

TABLE 10

Comparative Table of Permissible Heterophoria Limits

<i>Air Force</i>	<i>Maximum values in prism dioptres</i>		
	<i>Esophoria</i>	<i>Exophoria</i>	<i>Hypophoria or hyperphoria</i>
France	6	6	1
Federal Republic of Germany	10	5	1.5
United Kingdom	6	8	1
Canada	6	6	1
Belgium	8	6	1
Norway	10	5	1.5
USAF	10	5	1.5
US Navy	10	10	1
US Army	10	5	1.5

The legitimate question may therefore be asked whether it would not be better to review the whole matter, with no preconceived ideas, rather than stick to texts which have given rise to controversy for more than 20 years.

Binocular fixation power, as measured in the red lens test, is a requirement in five of the regulations (Norway, Belgium and the three American Services). The test method is the same in all of them. A deviation of binocular vision of more than 25° in the Belgian regulations, or more than 20° in the US and the Norwegian regulations, entails rejection. This test does not appear in the other four regulations.

Two of the regulations require measurement of *prism divergence at 6 metres*.

In the German regulations, this must not be less than 4 prism dioptres in the horizontal plane or 2 prism dioptres in the vertical plane.

The Belgian regulations state that it must not be less than 2 prism dioptres, without distinguishing between the various planes.

(d) *Visual field*

All the regulations associate fitness with normality of the peripheral and central fields of vision.

The French and the Canadian regulations confine themselves to this concept of normality and add no further remarks. The UK offers an opportunity for tolerance in cases of abnormality, but without defining this precisely. The statement under this heading runs as follows: "A defect of the visual field, particularly of the temporal fields, unless produced by a small quiescent lesion, entails rejection."

In the other six regulations the acceptable limits for any reduction in the peripheral visual field are fully specified: Peripheral reduction due to an anatomical conformation of the orbit or the shape of the eyelids must not be greater than 15%. Two of these six regulations also provide what they consider as the normal limits for the visual field, but these, unfortunately, are by no means in agreement, so that the uniformity represented by the concept of 15% is in fact only apparent and approximate.

Indeed, in the Belgian regulations the normal limits of the visual field are: 90° temporally, 65° nasally, 55° superiorly and 70° inferiorly.

The AFM 160-1 of the USAF quotes the following normal limits: temporally 90° or more, superotemporally 62°, superiorly 52°, superonasally 55°, nasally 60°, inferonasally 55°, inferiorly 70°, and inferotemporally 85°.

(e) *Distance and depth perception*

As already mentioned above, determination of this perception is not stipulated in the UK and the Belgian regulations. The other regulations use the same techniques and the normality standard is clearly laid down in the three different techniques which can be used.

The real problem which arises in connection with the proposed tests for determining distance and depth perception ability in candidates for training as pilots concerns the actual significance of these tests in the selection of pilots. The question is whether it is reasonable and justified to reject candidates who fail these tests, whereas an assessment of distances and depth during take-off, in flight, and on landing involves important factors which are missing from these selection tests. This particular problem was touched upon earlier.

(f) *Night morphoscopic threshold*

There is agreement on the rejection of candidates whose past history or whose performance during the ophthalmic examination reveals defective dark adaptation.

As the test is conducted only when circumstances require it, and as the equipment used differs from country to country, it would seem neither useful nor profitable to make a more detailed comparative investigation of this point within the framework of the present study.

(g) *Intraocular tension*

The upper limit of normality is fixed at 21 mm Hg in the technical notice annexed to the French regulations. A limit of 22 mm Hg is fixed in the USAF, US Navy, US Army and Norwegian regulations for the condition described as "preglaucoma", which entails rejection.

There is thus complete agreement on the intraocular tensions which are incompatible with fitness.

The other regulations quote no numerical values and simply require intraocular tension to be normal.

2. *Fighter, Reconnaissance or Bomber Pilots Flying in Jet Aircraft – Helicopter Pilots*(a) *Visual acuity*

The standards for visual acuity, measured at 6 metres (20 feet), before instillation of a cycloplegic, differ from regulation to regulation.

The limits of the visual acuity still compatible with fitness for such flying duties are presented in Table 11.

Near vision

See above reference to candidates for training as pilots: some of the regulations make no mention of any requirements in this connection. The wide variety of Tables used has already been pointed out.

Refraction

At the objective refraction examination, after the instillation of a cycloplegic, the following Table shows the maximum values acceptable for the various refractive defects (Table 12).

(b) *Accommodation*

The near point of accommodation must not exceed certain limits which are fixed according to age. As mentioned above, some regulations contain a Table giving these details. For all practical purposes the differences in the various regulations are unimportant.

TABLE 11

Minimum Visual Acuity Required in the Various Air Forces

<i>Air Force</i>	<i>Minimum vision without corrective glasses</i>		<i>Minimum vision required with corrective glasses</i>	
France	$\frac{8}{10}$	$\frac{8}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
Federal Republic of Germany	$\frac{3}{10}$	$\frac{3}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
United Kingdom	$\frac{5}{10}$	$\frac{5}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
Canada	$\frac{3}{10}$	$\frac{3}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
	} or	$\frac{6}{12}$	$\frac{10}{10}$	$\frac{10}{10}$
		$\frac{6}{30}$ (2)	$\frac{10}{10}$	$\frac{10}{10}$
Belgium	}	$\frac{7}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
		$\frac{5}{10}$ (1)	$\frac{10}{10}$	$\frac{10}{10}$
Norway	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
USAF	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
US Navy	$\frac{4}{10}$	$\frac{4}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
US Army	$\frac{2}{10}$	$\frac{2}{10}$	$\frac{10}{10}$	$\frac{10}{10}$

(1) This standard applies only to pilots who have been flying for at least 10 years and who have completed 1000 flying hours in operational aircraft.

(2) Flexibility clauses, below this standard, are admitted in some cases (see above).

TABLE 12

Maximum Acceptable Refraction Values

<i>Air Force</i>	<i>Maximum acceptable hypermetropia in dioptres</i>	<i>Maximum acceptable astigmatism in dioptres</i>	<i>Maximum acceptable myopia in dioptres</i>
France	2.5	not applicable	not applicable
Federal Republic of Germany	4.0	2	1.5
United Kingdom	2.25	not applicable	not applicable
Canada	3.5	1.25	1
Belgium	not applicable	not applicable	not applicable
Norway	5.5	3	5.5
USAF	5.5	3	5.5
US Navy	not applicable	not applicable	1.25
US Army	not applicable	not applicable	not applicable

The near point of convergence is exactly the same as that for candidates for training as pilots. In the Belgian regulations an exception is however made in the case of Army light aircraft pilots for whom the upper acceptable limit is 100 millimetres.

(c) *Heterophoria*

The heterophorias must meet the same requirements as for candidates for training as pilots, with the exception of the following two sets of regulations.

The Belgian regulations are more tolerant in the case of pilots who have had at least 10 years' flying experience. These tolerance limits are 10 prism dioptres of esophoria, 6 prism dioptres of exophoria and 1 prism dioptre of hyperphoria.

The hyperphoria tolerance is slightly higher in the US Navy. The limits are: 10 prism dioptres for esophoria and exophoria, and 1.5 prism dioptres for hyperphoria.

(d) *Visual fields*

The standards are the same as for candidates for training as pilots.

(e) *Distance and depth perception*

When applicable, the standards to be met are the same as for candidates for training as pilots.

The test is performed in the German Air Force, though the result of the test is not taken into account in the case of experienced pilots.

It is not conducted in other Air Forces (Belgium, UK).

This is sufficient proof that the proposed tests inspire little or no confidence as to their practical value.

(f) *Night morphoscopic threshold*

It must be normal.

The standards to be met are the same as those for candidates for training as pilots.

(g) *Intraocular tension*

See requirements previously mentioned for candidates for training as pilots. In actual fact, four regulations merely state that intraocular tension is required to be normal. The other five have determined the limits beyond which a subject must be declared unfit: the French, USAF, US Navy, US Army and Norwegian regulations have fixed this threshold of non-acceptance at 22 mm Hg or a difference of more than 4 mm Hg in the tension between the two eyes.

(h) *Wearing of contact lenses*

The use of contact lenses is prohibited in all the regulations. This is therefore a general rule, and is applied without exception in the three American regulations and in the Belgian, Canadian, German and Norwegian regulations.

Two countries, France and United Kingdom, can authorise the wearing of contact lenses, but only in certain circumstances.

In France these circumstances are very strict and very limited. Visual standards 4 and 5 are the only ones in which provision is made for the possible use of contact lenses, but each specific case must be individually approved after an objective tolerance examination.

In the Royal Air Force, aircrew may be authorised to wear contact lenses only with the approval of the consultant ophthalmologist. The text of the regulations gives no details about the conditions in which such authorisation is granted.

3. *Military Transport Pilots*

With the exception of distant visual acuity, what has been said above about combat aircraft pilots is equally valid for military transport aircraft pilots.

Remarks will therefore be confined to a comparison of the limits fixed by the various regulations for distant visual acuity so that the latter remains compatible with fitness to perform the duties of a transport aircraft pilot. To supplement this comparison, Table 13 on facing page includes the ICAO standards for civil aviation transport aircraft pilots. This Table illustrates the variety of the requirements under this heading.

TABLE 13

**Minimum Visual Acuity Requirements for Transport Aircraft Pilots
as Laid Down by Various Air Forces and by ICAO**

<i>Air Force</i>	<i>Minimum vision without corrective lenses</i>		<i>Minimum vision with corrective lenses</i>	
France	$\frac{5}{10}$	$\frac{5}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
Federal Republic of Germany	$\frac{3}{10}$	$\frac{3}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
United Kingdom	$\frac{5}{10}$	$\frac{5}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
Canada	$\frac{3}{10}$	$\frac{3}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
	or			
	$\frac{6}{12}$	$\frac{6}{30}$	$\frac{10}{10}$	$\frac{10}{10}$
Belgium	$\frac{3}{10}$	$\frac{3}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
Norway	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
USAF	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
US Navy	$\frac{4}{10}$	$\frac{4}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
US Army	$\frac{2}{10}$	$\frac{2}{10}$	$\frac{10}{10}$	$\frac{10}{10}$
ICAO	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{6}{9}$	$\frac{6}{9}$

C. COLOUR PERCEPTION**(a) France**

Colour perception requirements are laid down in two standards. (See Annex 1.)

1. Colour Perception Standard 1 (SCA/1)

This applies to the following:

candidates for training as pilots — all categories,
 candidates for training as transport aircraft pilots,
 candidates for training as navigators, bomb-aimers, radar operators,
 candidates for training as transport aircraft navigators,
 candidates for training as observers and air-gunners,
 fighter pilots,
 reconnaissance pilots,
 bomber pilots (jet aircraft),
 transport pilots,
 bomber pilots (conventional type aircraft),
 twin-engine communications aircraft pilots,
 helicopter pilots,
 ab initio flying instructors,
 navigators, gunners, radar operators.

Under this standard colour perception must be normal. The colour perception test is carried out by means of the Ishihara pseudo-isochromatic plates.

These plates are read at a distance of approximately 75 centimetres. The charts, inclined at 45° to the horizontal, are illuminated by an Easel Macbeth type of lamp.

Each plate is presented to the subject for two seconds.

2. *Colour Perception Standard 2 (SCA/2)*

This standard applies to the following:

- candidates for training as flight engineers,
- candidates for training as female flight attendants,
- candidates for training as military reserve pilots,
- liaison aircraft pilots,
- pilots of light support single-engine aircraft,
- military reserve pilots,
- transport aircraft navigators,
- radio-navigators,
- flight radio operators,
- air gunner observer,
- flight refuellers,
- flight engineers,
- female flight attendants,
- candidates and flying personnel of the light aviation of the Army and the Gendarmerie.

This standard requires subjects to recognise immediately the coloured lights used in aviation.

Subjects who make mistakes when reading the Ishihara pseudo-isochromatic plates are given a Beyne chromop-tometric lantern test. This test presents light transmitted through coloured screens representing the red, yellow, green, blue and white signal lights, which are examined for 1/25 of a second from a distance of 5 metres with an apparent diameter of two minutes.

The lights are presented one by one on various occasions. Any subject who makes a mistake when reading aviation red, aviation green, aviation yellow, aviation blue or aviation white *must* be rejected. No tolerance can be allowed, and no presentation of the lights a second time can be permitted.

(b) **Belgium**

Candidates for flying duties and serving members of the flying personnel must have normal colour perception. This is determined by means of the Ishihara test, presented squarely to the subject at a distance of 60 centimetres and in natural lighting.

Other pseudoisochromatic charts (American Optical Company or equivalent charts) may also be used. Colour perception is considered to be normal if the subject reads correctly at least 14 of the 17 charts presented to him (test of the American Optical Company).

(c) **United Kingdom**

Colour perception must be normal.

It is determined by means of the Ishihara test.

If mistakes are made during the reading of the Ishihara plates, an approved lantern test (Giles-Archer, Martin) is carried out. In such cases acceptance of the candidate is dependent on his making no mistakes whatever during this lantern test.

(d) **Canada**

Colour perception is determined by means of the Ishihara test. To pass, candidates must make no errors on the first test, or one error on the first test but none on the repeat test. Their grading under the heading of Colour Vision is then CV1.

A candidate who fails the Ishihara test is then subjected to the coloured lights lantern test. If he makes no errors on the first test or one error on the first test but none when the test is repeated, his CV grading is CV2. Under the standards in the regulations such a candidate is assessed as fit to perform the various duties of flying personnel.

(e) Federal Republic of Germany

Colour perception is determined by means of:

1. the Stilling-Velhagen pseudoisochromatic plates, placed at a reading distance of 1 metre, or the Ishihara plates, placed at a reading distance of 75 centimetres, in adequate natural lighting conditions, the plates being presented for a period of 3 seconds;
2. anomaloscopy: this test is mandatory at the initial examination and optional at the periodic examinations.

All members of the flying personnel must have normal colour perception.

(f) USAF

Colour perception is tested with the "Vision Test Set – Color Vision (VTS – CV)". This consists of 15 pseudoisochromatic plates illuminated by an Easel Macbeth lamp (see (a) France above). One of the plates is used as a demonstration plate. The test therefore comprises the reading of 14 plates. If the subject makes any mistakes when reading these plates, he is tested with the "Vision Test Apparatus – Color Threshold Tester (VTA – CTT)".

The purpose of the VTA – CTT is to *quantify* the degree of deficiency of the subject's colour perception.

A score of 50 or more on the VTA – CTT indicates a mild or Grade 1 deficiency, considered to be compatible with flight safety and, consequently, with fitness for flying duties. A score of between 35 and 49 indicates a moderate or Grade 2 deficiency, a score of less than 35 indicates a Grade 3 deficiency.

Grades 2 and 3 are not compatible with fitness for flying duties.

Since congenital colour perception deficiency does not change throughout life, it is unnecessary to repeat the test annually, if the test performed at the initial examination has been carefully carried out and provides sufficient guaranty.

Normal colour perception is required for all aircrew members.

Perception is considered to be normal if there are at least 10 correct replies from the reading of the 14 plates on the VTS – CV.

Five incorrect replies, including failure to reply, if the subject cannot reply to certain plates, are therefore sufficient to entail rejection, unless he has scored at least 50 during the VTA – CTT test.

(g) US Navy

Colour perception is determined by two methods:

1. the Farnsworth lantern test (FALANT);
2. the pseudoisochromatic plates (see (f) USAF above). These plates are used only if a Farnsworth lantern is not available.

If the set of 15 pseudoisochromatic plates is used, the subject must read correctly 10 of the 14 actually used for the test, in order to qualify.

If the old 17-plate test set is used, the subject must read 14 plates correctly.

If the old 20-plate test set is used, 17 correct replies are required.

In cases of doubtful answers, the results taken into consideration for the final decision are those of the Farnsworth lantern test.

Normal colour perception is required for all duties performed by flying personnel.

(h) US Army

The test apparatus is the same as that used by the US Navy, described above. The colour perception standard for Class 1 (candidates for flying duties and students undergoing training) requires normal perception. The following are causes for rejection:

- five or more errors when reading the set of 14 pseudoisochromatic plates (VTS – CV);
- or four or more errors if the old set of 17 pseudoisochromatic plates is used.

The standard for Class 2 (serving personnel) and for Class 3 (personnel who make flights as and when the need arises, but who are not involved in the control of the aircraft) also requires normal colour perception.

The subject is rejected if he:

1. makes at least 5 errors in reading the set of 14 pseudoisochromatic plates;
or
2. makes at least 4 errors in reading the 17-plate test set;
or
3. fails the Farnsworth lantern test.

(i) Conclusions

Examination techniques in all the regulations rely on the Ishihara pseudoisochromatic plates, or similar type of plates.

Some Air Forces use apparatus in which the colour perception tests are integrated in their operational programme, but the method is similar to that of the pseudoisochromatic plate test.

In the event of errors in the replies given to presentation of the pseudoisochromatic plates, the majority of the regulations require the use of a lantern which reproduces the signalling lights used in aviation. The French regulations, however, give less importance to this method, as is seen by the fact that a "Standard 2" is created for those who pass the lantern test after failing the pseudoisochromatic plate test, and that subjects in this category are debarred from employment as pilots of combat aircraft, transport aircraft, or helicopters, or as navigator, bomb-aimer, radar operator, or navigator in a transport aircraft.

To complete the picture in greater detail it should be noted that:

- (a) the Federal German Air Force supplements the pseudoisochromatic plate test with an anomaloscopic test at the initial examination;
- (b) the USAF also supplements the pseudoisochromatic plate test by a technique which quantifies the degree of deficiency by giving it a precise value.

In all the regulations *normal* colour sense is therefore required in all candidates for flying duties, and in all serving personnel engaged on such duties.

On the other hand, although the same kind of test (pseudoisochromatic plates) is used, the interpretation of what constitutes normality is not, however, exactly the same in the various regulations. In some of them, for instance, colour perception is considered to be normal only if there have been no errors in reading the complete set of pseudoisochromatic plates, while in others four errors are still assumed to be consistent with normality.

Since practically the same tests are in use in all the Air Forces, it is obviously desirable to come to some agreement so that ultimately a common concept of *normality* can be arrived at, which is consistent with fitness for employment as a member of the flying personnel.

CHAPTER XVII

EAR, NOSE AND THROAT

An examination of the ear, nose and throat requirements will cover the following:

- A. Pathology of the nose, the pharynx, the larynx and the adjacent cavities;
- B. Pathology of the ear;
- C. The auditory function.

A. PATHOLOGY OF THE NOSE, THE PHARYNX, THE LARYNX AND THE ADJACENT CAVITIES

(a) Initial Examination

The nasal cavities must permit normal ventilation.

Deviation of the nasal septum, hypertrophy of the turbinates, when they cause an appreciable reduction in nasal ventilation, acute or chronic infections of the upper respiratory tracts or of their adnexae, constitute causes for temporary or permanent unfitness, depending on their degree of curability and the post-operative effects on the functioning of the organs concerned.

Malformations giving rise to speech difficulties or stuttering are disqualifying.

This is the text presented in the French regulations. This general statement covers all the points which are found, in a much more detailed form, in the other regulations. The USAF in particular gives a very comprehensive list of the conditions which are causes for rejection for flying duties at the initial examination.

A few main points of a practical nature will be noted below in the form of comments, in order to clarify certain aspects in the regulations or make comparisons.

1. *Speech During Radiocommunication*

Harelip, affecting the bony mass or causing unsightly disfigurement of the subject, or likely to interfere with clear speech during radiocommunication, is obviously a cause for rejection. If, however, the harelip does not affect the bony mass and surgical repair has resulted in normal speech, the subject may be accepted for flying duty. This concept appears in the text of eight of the regulations (USAF, US Army, US Navy, Norway, Belgium, Federal Republic of Germany, UK, Canada).

Because of their effect on speech intelligibility, hoarseness of the voice, paralysis of a vocal chord and, generally, any defects in pronunciation which prevent a subject's speech from being comprehensible, are disqualifying. The German regulations, however, state that a *slight* lisp is acceptable.

2. *Paranasal Sinuses*

- (1) The German regulations are alone in requiring a *routine X-ray* of the sinuses at the initial medical examination. Other regulations, particularly those for the American Forces, state that diaphanoscopy of the sinuses and their X-ray evaluation should be performed when indicated, that is, in the presence of symptoms of a sinus disease.

- (2) Chronic sinusitis is quoted in all the regulations as a cause for rejection, unless it is so mild as to be unlikely to affect the performance of flying duties. The following tolerance which may be allowed under the US Army regulations should be noted:

"Acute or chronic sinusitis of any degree entails an assessment of unfitness at the initial examination. If there is only X-ray evidence of chronic sinusitis and the history reveals the examinee to have been asymptomatic for 5 years, this X-ray finding alone will not be considered as rendering the individual medically unfit."

3. *Obstruction of the Airways*

All the regulations stipulate rejection of the subject when the obstruction of the airways interferes "more than moderately" with nasal breathing (USAF regulations).

The US Army and the Belgian regulations provide a numerical value to define the degree of interference sufficient to be a cause for rejection: "Obstruction of the airways resulting in a 50% reduction in ventilation of the nasal cavities on either side or interfering with drainage of a sinus is disqualifying." However, in the Belgian regulations, this text applies only to Air Force candidates and serving members of the flying personnel of the Air Force and not to candidates and serving flying personnel of the Army Light Aviation, the flying duties carried out by light aviation aircraft being of a less exacting nature as far as changes in flight altitude are concerned.

4. *Allergic or Vasomotor Rhinitis*

This disease is specifically mentioned, in nearly all the regulations, as a cause for rejection.

The same applies to a past history of this affection, unless, according to the USAF, US Army and US Navy regulations, the subject has been free of any recurrence since the age of 12 years.

5. *Surgical Intervention for Sinusitis, Polyposis or Tissue Hyperplasia*

The majority of the regulations recommend temporary unfitness until recovery is complete. The USAF adds, as additional requirements, that the anatomical structure must be functionally normal and that the subject must be subjectively and objectively normal for a period of one year following the operation.

Similarly, the surgical removal of nasal polypi must be followed by a period of at least one year prior to initial medical examination and the candidate cannot be assessed as fit unless there has been no recurrence during that time.

(b) Periodic Examinations

The requirements for assessing fitness for flying duties are, in the main, the same as those for the examination on entry into the Service. The basic criterion by which fitness, temporary or permanent unfitness for flying duties are assessed is the functional ability of the parts affected, following medical or surgical treatment.

(c) Conclusions

No differences exist on the major points referred to in the regulations under the above headings. Some of them, however, have been concerned to give long lists of diseases which are causes for rejection and to supplement them with details of a practical nature aimed at unifying the final decisions made by the assessors.

One point would appear to be surprising when referring to chronic sinusitis: none of the regulations advocates or mentions the use of the low pressure chamber to determine the adequacy of ventilation of the ostium of a sinusal cavity.

B. PATHOLOGY OF THE EAR

(a) Initial Examination

All the regulations contain the following general principles:

1. The external ear must be normal and, in particular, must not show any atresia of the auditory canal or any deformity of the auricle which may be associated with a marked tenderness to the constant pressure exerted by headphones or helmet; there must be no established acute or chronic disease of the external ear.
2. The middle ear must be sound.
 - (1) Any acute or sub-acute catarrhal otitis media is a cause for rejection. Any acute or chronic necrotic or purulent otitis media or any sequela of necrotic or suppurative otitis is a cause for rejection.

Otosclerosis is also always a cause for rejection.

With regard to the drum, perforation of the tympanic membrane, even when drained or in the form of a puncture, is disqualifying.

- (2) Tympanic membrane scars, which are frequently found in candidates, are the subject of texts which, though somewhat different in form, all express the same view which can be summed up perfectly in the following sentences from the UK regulations: "The assessment for flying duties of all scars of the tympanic membrane is a matter of clinical judgement as to their liability to break down. Scars which are flaccid and liable to rupture should disqualify for flying duties."

The French regulations envisage the positive facet of the situation by stating the conditions compatible with fitness: "Tympanic membrane scars are considered compatible with flying duties, depending upon tubal patency, which should be checked, if necessary, during a simulated climb test in a low pressure chamber."

The other regulations are stricter and more inclined to require rejection. They deal mainly with the negative aspects of the question, that is, the existence of conditions which justify disqualification.

The Belgian, Canadian and German regulations do not accept subjects with serious atrophic scarring of the tympanic membrane.

In a desire to make the wording of the text as precise as possible, the American Armed Forces provide details to supplement the conditions which are causes for rejection. In the USAF and the US Army, a high degree of scarring of the tympanic membrane is disqualifying if associated with a reduction of auditory acuity of at least 20 decibels ASA at the frequencies 500, 1000 and 2000 Hz in either ear, regardless of the hearing level in the other ear.

The US Navy summarises concisely the positive or negative statements formulated by the other regulations by maintaining the same uniformity of concept:

"The presence of a small scar caused by trouble several years previously, which has not recurred and with which there is no deficiency of hearing and no evidence of other inflammation, does not disqualify. Actual perforation, or marked retraction of a drum membrane following chronic ear disease, disqualifies."

- (3) Tubal patency must be sufficient "to enable changes in altitude, at the rates of descent normally applied in flight by the aircraft of the particular Force concerned, to be withstood without causing interference or barotrauma" (Belgian regulations). This text puts into specific terms the idea expressed in this connection by all the regulations. The American regulations include a sub-paragraph in which inability to perform the Valsalva manoeuvre is cause for rejection. Because of the importance of patency of the Eustachian tube, the UK regulations describe three methods which the examiner can use during the medical fitness examination to test patency: Valsalva's method, politzerization and catheterization.

In the Belgian Air Force all candidates are routinely subjected to a low pressure chamber test: any difficulty in ventilation of the middle ear entails temporary or permanent unfitness, depending on the degree and the cause of the difficulty.

- (4) Surgical interventions on the middle ear, particularly a stapedectomy, are disqualifying.

With regard to mastoid operations, there are no differences between the various regulations: a history of a radical mastoidectomy or a petromastoidectomy is always a cause for rejection. It is unanimously agreed that a simple mastoidectomy which has healed correctly is not disqualifying. The UK regulations also require in such cases that the tympanic membrane should be intact and present no evidence of disease.

- (5) The inner ear must be intact.

All the regulations require normal vestibular and auditory functions and reject any individuals whose past history reveals numerous attacks of vertigo, with or without nausea, vomiting, tinnitus, hearing loss, or any other symptoms of disease of the inner ear. In short, and taking the wording of the USAF text, which is in complete agreement with the spirit and the texts of the other regulations, any disease of the ear with subjective or objective evidence of sequelae which interfere with the auditory or vestibular functions is a cause for rejection.

- (6) Excessive susceptibility to air sickness and to motion sickness based on acceptable and verifiable history should suggest vestibular hyperexcitability or a vestibular lesion.

Some of the regulations quote the caloric, postural and rotation tests to be used for evaluating vestibular responses in this connection (see the German regulations). The majority, however, are cautious in their recommendations about the choice of tests and the interpretation to be placed on their results.

(b) Periodic Examinations

Generally speaking, the causes for rejection are the same as those which disqualify candidates at their initial examination.

There is, however, a wider measure of tolerance in the case of experienced flying personnel when sequelae of diseases of the ear do not give rise to functional effects which are prejudicial to the satisfactory performance of flying duties. In some instances, because of the persistency of sequelae, a limitation is placed on the type of flying duties to be undertaken. In the case of the most commonly found diseases, the German and the American regulations state the decisions to be taken by the examiner.

The other regulations rely on the clinical judgement of the medical examiner, with all the vagueness and uncertainty which this method may imply for any uniformity of views when arriving at an assessment.

Two instances should, however, be pointed out in which the precise working of the texts leaves absolutely no doubt about the conditions which must be present at a periodic examination for an assessment of medical fitness which, if the same case occurred at an initial examination, would not be granted.

1. Perforation of the Tympanic Membrane

When it is limited, non-marginal and when there has been no drainage for several months, this condition may be acceptable for the performance of all types of flying duties, provided its effect on the auditory function enables the

subject to meet the standards laid down for the hearing requirements (French regulations).

Perforation of the tympanic membrane must be asymptomatic and not likely to interfere with the performance of flying activities (USAF regulations).

In aeronautical practice these two texts are thus in line with each other.

2. *Tympanoplasty and Surgery of the Middle Ear and the Internal Ear*

The *French regulations* emphasize that sequelae of interventions under the heading of tympanoplasty and surgery of the middle and internal ear should be assessed in relation to the results of the exploration of the cochleo-vestibular system and of the patency of the Eustachian tube. The latter includes, as necessary, a simulated climb test in a low pressure chamber.

These investigations cannot be made until three to six months after the operation.

At best, the decision in such cases cannot be more than a grading under the Class 2 medical fitness standard, that is, in the case of pilots, being debarred from undertaking duties as a jet fighter, reconnaissance or bomber pilot, and being restricted to acting as pilot of a transport aircraft, conventional type bomber aircraft, twin-engined communications aircraft, helicopter, liaison aircraft, single-engined light aircraft, or as an ab initio flying training instructor.

The *German regulations* have reflected a similar point of view. Candidate pilots are unfit if they have a history of such surgical operations. Trainee flying personnel and experienced flying personnel on flying duties can recover their flying category after such surgical operations provided the other requirements of the regulations are met (hearing standards, motility of the eardrum, tubar patency, etc....)

Under the US Army regulations, following a period of temporary unfitness after a tympanoplasty, the subject may again be assessed as fit after recovery, if hearing is acceptable and motility of the eardrum is satisfactory.

The USAF and US Navy are not so explicit in their requirements, though they nevertheless state, in a text of a more general character, that any surgical operation on the ear entails rejection until recovery is complete and the ear is functioning normally again.

The Norwegian regulations are identical with those of the USAF.

No mention of these problems is made in the Belgian, the UK or the Canadian regulations, which thus leave all decisions to the good clinical judgement of the examiners.

(c) **Conclusions**

The pathology of the ear is a frequent cause for permanent or temporary unfitness for flying duties. The text of the various regulations therefore discusses in detail the most commonly occurring practical aspects of this pathology. No fundamental differences are noted in this particular field.

Among the European regulations, those of the Federal Republic of Germany give the most comprehensive classification of this pathology by including an indication of it in the decisions to be taken by the examiner in regard to fitness both at the initial and the periodic examination of the various categories of flying personnel.

This same procedure is followed in the American regulations.

In matters relating to surgical interventions on the eardrum, middle ear and inner ear, some of the regulations present gaps and omissions. This is probably the field in which some attempt to clarify ideas would be most worthwhile at the present time, so that account could be taken of the functional results of a type of surgery the technique of which has shown considerable advances during the last twenty years.

C. **THE AUDITORY FUNCTION**

(a) **Measurement of Hearing Acuity**

Hearing acuity is measured by means of an audiometer, the subject being placed in a soundproof chamber. A pure tone air conduction audiogram is obtained on all candidates for flying duties. In certain cases, more detailed investigation may be necessary, using various pure tone and speech audiometric tests. This is the examination technique which is used at all the aircrew medical examination centres.

Some regulations also include the whispered voice test at a distance of 15 feet. This is a survival of an old test which belongs to the traditional past history of aviation medicine. Comments on this test add that it is performed only when

audiometric equipment is not available, but that in case of doubt whether hearing acuity is normal, audiometric tests are necessary in order to assess fitness (US Navy, US Army and RAF regulations).

It should be noted that the ICAO regulations for the granting of licences to civil aviation flying personnel also prescribe the use of pure tone or speech audiometry. For candidates with a hearing loss greater than the audiometric limits indicated in the Hearing Requirements No.1, a test is introduced to determine ability to hear an average conversational voice in a quiet room, the subject using both ears and standing with his back to the examiner at a distance of two metres (6 feet) from the latter. This test is sufficient in itself to meet the Hearing Requirements No.2 of ICAO. The ICAO regulations add that for the purpose of the Hearing Requirements No.1 and No.2, the sound level of the average conversational voice at point of output ranges from 85 to 95 decibels. It should be added immediately that this average conversational voice test, the inaccuracy of which will not be stressed here, is not to be recommended in military practice. All the military regulations covered by the present study express their requirements in such a manner as to indicate that the pure tone audiogram is an *absolutely essential* element in ascertaining and measuring any hearing deficiency of the subject being examined, the other method being an occasional expedient.

(b) Hearing Standards

The provisions relating to the hearing standards to be met before undertaking any of the various types of aircrew duties will now be reviewed and compared (see (c): Conclusions).

When hearing defects, as measured by pure tone audiometry, are expressed in decibels, these are always, in the regulations studied, *ASA* (American Standard Association) *decibels*. To convert them to *ISO* (International Standards Organization) *decibels*, the following values are added to the number of *ASA* decibels noted at the relevant frequencies:

Frequency	Decibels to be added
250 Hertz	15 dB
500 Hertz	15 dB
1000 Hertz	10 dB
2000 Hertz	10 dB
3000 Hertz	10 dB
4000 Hertz	5 dB
6000 Hertz	10 dB
8000 Hertz	10 dB

1. France

The French regulations provide for three *hearing standards* (Annex 1):

(1) Hearing Standard 1 (SAA/1)

This applies to the following:

- (a) candidates for training as pilots, all categories;
- (b) candidates for training as transport aircraft pilots;
- (c) candidates for training as navigators, bomb-aimers, radar operators;
- (d) candidates for training as navigators of transport aircraft;
- (e) candidates for training as female flight attendants.

To meet this Hearing Standard 1, the loss observed on the pure tone air conduction audiogram for each ear must not be more than 20 decibels at each of the frequencies 250, 500, 1000 and 2000 Hz, and not be more than 30 decibels at each of the frequencies 3000, 4000 and 8000 Hz.

This limit may, however, be increased to 40 dB at the frequency 3000 Hz, and to 50 dB at the frequency 4000 Hz in the case of regular military personnel who apply for employment as flying personnel. All such applicants undergo a speed intelligibility test which must meet the requirements for Hearing Standard 2.

(2) Hearing Standard 2 (SAA/2)

This standard applies to the following:

- (a) candidates for training as flight engineers;
- (b) candidates for training as military reserve pilots;
- (c) candidates for training as air gunner observers;
- (d) fighter pilots;
- (e) reconnaissance pilots;
- (f) bomber pilots (jet aircraft);
- (g) transport aircraft pilots;
- (h) bomber pilots (conventional type aircraft);
- (i) pilots of twin-engined communications aircraft;
- (j) helicopter pilots;

- (k) military reserve pilots;
- (l) ab initio flying training instructor pilots;
- (m) navigators, bomb-aimers, radar operators;
- (n) navigators of transport aircraft;
- (o) radio navigators;
- (p) aircraft radio operators;
- (q) air gunner observers;
- (r) flight refuellers;
- (s) flight engineers;
- (t) female flight attendants;
- (u) candidate flying personnel of the light aviation of the Army and the Gendarmerie.

To meet the requirements of Hearing Standard 2, the loss observed on the pure tone air conduction audiogram for each ear must not be more than 30 decibels for each of the frequencies 250, 500, 1000 and 2000 Hz, 40 decibels for the frequency 3000 Hz and not be more than 50 decibels for the frequency 4000 Hz.

If this audiometric test does not give satisfactory results, a speech intelligibility test is conducted with and without masking noise, either in a free field or with headphones, both ears being tested simultaneously. The sound level in the chamber is approximately 85 decibels for the free field test, and 65 decibels for the test with headphones.

The characteristics of the curves obtained are defined as follows:

1. without masking noise: a curve the slope of which is sufficient to achieve 100% intelligibility in 30 decibels, with a loss at the 50% threshold not exceeding 25 decibels;
2. with masking noise: a curve the slope of which is sufficient to achieve 100% intelligibility in 30 decibels, with a loss at the 50% threshold not exceeding 15 decibels.

(3) *Hearing Standard 3 (SAA/3)*

This standard applies to the following:

- (a) pilots of liaison aircraft;
- (b) pilots of single-engined light support aircraft;
- (c) flying personnel of the light aviation of the Army and the Gendarmerie.

To meet the requirements of Hearing Standard 3, the loss observed on the pure tone air conduction audiogram for each ear must not be more than 40 decibels for each of the frequencies 250, 500, 1000 and 2000 Hertz, 50 decibels for the frequency 3000 Hertz, and 60 decibels for the frequency 4000 Hertz.

If this audiometric test does not give satisfactory results, a speech intelligibility test is performed under the same conditions as for Hearing Standard 2.

The characteristics of the curves obtained are defined as follows:

1. without masking noise: a curve the slope of which is sufficient to achieve 100% intelligibility in 40 decibels, with a loss at the 50% threshold not exceeding 30 decibels;
2. with masking noise: a curve the slope of which is sufficient to achieve 100% intelligibility in 40 decibels, with a loss at the 50% threshold not exceeding 20 decibels.

2. *Belgium*

(1) *Initial examination*

Loss of hearing acuity, as measured with a pure tone audiometer in a room in which the intensity of the background noise is less than 20 decibels, must not be more than 15 decibels at the frequencies 250, 500, 1000, 2000 and 3000 Hertz.

At the frequencies 4000, 6000 and 8000 Hertz, the average loss, calculated from the two frequencies at which the losses were highest, must not be more than 40 decibels for both ears, that is, by taking for each ear the two frequencies out of the frequencies 4000, 6000 and 8000 Hertz at which the losses were highest, the sum total of these losses must not exceed 160 decibels for the two ears.

However, in the case of candidates for flying duties in the Army light aviation, auditory acuity, when measured under the same conditions as those stated above, must not be reduced by more than 30 decibels at the frequencies 250, 500, 1000, 2000 and 3000 Hertz in one ear, provided the reduction in the other ear at the same frequencies does not exceed 15 decibels. At the frequencies 4000, 6000 and 8000 Hertz, the average loss in both ears, calculated from the two frequencies at which the losses were highest, must not be more than 40 decibels, that is, the sum total of the losses for the two frequencies out of the frequencies 4000, 6000 and 8000 Hertz at which the losses were highest must not exceed 160 decibels for the two ears.

(2) *Periodic examinations*

- (a) *For pilots of combat aircraft, navigators of combat aircraft and radio operators in transport aircraft* hearing acuity, when measured in the above conditions by air conduction must not show a loss of more than 20 decibels at each of the frequencies 512, 1024, 2048 and 3000 Hertz in the worse ear.

(b) *For transport aircraft and helicopter pilots, transport aircraft navigators and flight technicians* hearing acuity, when measured in the above conditions by air conduction must not show a loss of more than 20 decibels in the better ear and of more than 40 decibels in the worse ear at the frequencies 512, 1024 and 2048 Hertz.

(c) *For pilots of training aircraft and pilots of communications aircraft* hearing loss, when ascertained by air conduction must not be greater in one or in both ears than 40 decibels at each of the frequencies 512, 1024 and 2048 Hertz.

(d) *Exceptional provisions applicable to pilots*

Standards lower than those described above may be applied only in exceptional circumstances on the recommendation of the Chief of Staff of the Force concerned, and solely in the case of experienced pilots flying in aircraft in which control can be handed over to another experienced pilot present in the aircraft, without endangering flight safety.

3. *United Kingdom*

A forced whisper must be able to be heard at 6 metres with each ear separately.

All candidates for flying duties or all members of the flying personnel are also given two additional tests:

- (1) An audiometric test at the frequencies 250, 500, 1000, 2000, 3000 and 4000 Hertz. The hearing loss ascertained by air conduction must not be more than 20 decibels at each frequency, in each ear.
- (2) A speech intelligibility test against a background noise of 100 decibels, the words being transmitted at an average sound level of 106 decibels.

4. *Canada*

The maximum hearing loss compatible with fitness for flying duties, both for candidates and for experienced aircrew, is as follows: a hearing loss not exceeding 20 decibels in each ear in the frequency band 500 to 3000 Hertz.

5. *Federal Republic of Germany*

- (1) *For candidates for training as pilots (including helicopter pilots)*, hearing loss must not be greater than 20 decibels at each of the frequencies 250, 500, 1000 and 2000 Hertz. At the frequencies 3000, 4000 and 6000 Hertz the sum total of hearing loss in both ears must not exceed 210 decibels at the initial examination.
- (2) *For aircraft pilots and helicopter pilots, and for other members of the flying personnel* hearing loss must not be more than 30 decibels at each of the frequencies 250, 500, 1000 and 2000 Hertz.

If this standard is not met, the assessment is based on the results of a speech audiometric test conducted with and without masking noise.

6. *US Army*

- (1) *Hearing standard applicable for Class 1 and Class 1A (candidates for training as pilots and student pilots)*
Hearing loss as determined by pure tone air conduction audiometry in each ear separately must not be more than 15 decibels at each of the frequencies 500, 1000 and 2000 Hertz, and not be more than 40 decibels at 4000 Hertz.
- (2) *Hearing standard applicable for Class 2 (aviators, instructors, test pilots)*
Hearing loss as determined by pure tone air conduction audiometry must not be more in one ear than 20 decibels at each of the frequencies 500, 1000 and 2000 Hertz, and in the other ear, not more than 20 decibels at the frequency 500 Hertz, and 40 decibels at the frequencies 1000 and 2000 Hertz.
- (3) *Hearing standard applicable for Class 3 (personnel who make flights as and when the need arises without being responsible for the control of the aircraft)*
Hearing loss as determined by pure tone air conduction audiometry must not be more, in the better ear, than 30 decibels at the frequencies 500, 1000 and 2000 Hertz, no account being taken of any loss in the other ear.

7. *US Navy*

- (1) *Hearing standard for candidates for training as "Naval aviators"*
Hearing loss as determined by pure tone air conduction audiometry in each ear must not be more than 10 decibels at the frequency of 500 Hertz, not more than 15 decibels at the frequencies 1000 and 2000 Hertz, not more than 35 decibels at the frequency 3000 Hertz and not more than 50 decibels at the frequency 4000 Hertz.

- (2) *Hearing standard for Service Groups I and II ("aviators" under 45 years of age who are fit for operational flying duties)*

Hearing loss as determined by pure tone air conduction audiometry must not be more, in one ear, than 20 decibels at the frequencies 500, 1000 and 2000 Hertz, and in the other ear, not more than 20 decibels at the frequency of 500 Hertz, and not more than 40 decibels at the frequencies 1000 and 2000 Hertz.

- (3) *Hearing standard for Service Group III ("aviators" over 45 years of age and flying personnel passed fit but with certain limitations)*

Hearing loss as determined by pure tone air conduction audiometry must not be greater in the better ear than 30 decibels at the frequencies 500, 1000 and 2000 Hertz, no account being taken of any hearing loss in the other ear.

8. USAF and Norway

A pure tone air conduction audiogram is required at all medical fitness examinations. Hearing losses are determined at the frequencies 500, 1000, 2000, 3000, 4000 and 6000 Hertz. When the air conduction audiometric test reveals a serious defect in auditory acuity, a bone conduction audiometric test, a speech intelligibility test and other tests are made to help clarify the aetiology of the hearing loss.

- (1) *Hearing standard for candidate aircrew*

Hearing loss as determined in each ear by a pure tone air conduction audiogram must not be more than 15 decibels at the frequencies 500, 1000 and 2000 Hertz, and the sum total of hearing loss in both ears must not exceed 210 decibels at the frequencies 3000, 4000 and 6000 Hertz.

- (2) *Hearing standard for serving pilots and navigators*

Hearing loss as determined by a pure tone air conduction audiogram must not exceed 20 decibels in one ear at the frequencies 500, 1000 and 2000 Hertz and must not be more in the other ear than 20 decibels at the frequency of 500 Hertz, or more than 40 decibels at the frequencies 1000 and 2000 Hertz.

(c) Conclusions

As in the case of the visual standards, it is proposed to compare the hearing standards applicable to three major classes of personnel: candidates for training as pilots — all categories; pilots of combat aircraft and military transport aircraft pilots. This will highlight the differences between the various regulations under consideration.

1. Candidates for Training as Pilots — All Categories

TABLE 14
Comparative Table of Acceptable Hearing Loss Values
(candidates for training as pilots)

Frequency in Hz	Acceptable loss in decibels for each ear (ASA 1951 Standards)								
	France	Belgium	UK	Canada	Germany	US Army	US Navy	USAF	Norway
250	20	15	20	—	20	—	—	—	—
500	20	15	20	20	20	15	10	15	15
1000	20	15	20	20	20	15	15	15	15
2000	20	15	20	20	20	15	15	15	15
3000	30	total of 160 dB for the two frequencies at which hearing loss is greatest in both ears	20	20	total of 210 dB for both ears	—	35	total of 210 dB for both ears	total or 210 dB for both ears
4000	30		20	—		40	50		
8000	30		—	—		—	—		

The above Table shows that:

- (1) the frequency of 250 Hz is not used by five of the regulations;
- (2) at 500 Hz, one set of regulations accepts a maximum loss of 10 dB, four accept a maximum loss of 15 dB and four a maximum loss of 20 dB;
- (3) at 1000 Hz, five of the regulations accept a maximum loss of 15 dB, and four a maximum loss of 20 dB;
- (4) at 2000 Hz, five of the regulations accept a maximum loss of 15 dB, and four a maximum loss of 20 dB;
- (5) at 3000 Hz and more, the differences are such that a comparison is no longer useful.

2. *Combat Aircraft Pilots*

TABLE 15

Comparative Table of Acceptable Hearing Loss Values
(combat pilots)

Frequency in Hz	Acceptable loss in decibels for each ear (ASA 1951 Standards)								
	France	Belgium	UK	Canada	Germany	US Army	US Navy	USAF	Norway
250	30	—	20	—	30	—	—	—	—
500	30	20	20	20	30	20 + 20	20 + 20	20 + 20	20 + 20
1000	30	20	20	20	30	20 + 40	20 + 40	20 + 40	20 + 40
2000	30	20	20	20	30	20 + 40	20 + 40	20 + 40	20 + 40
3000	40	20	20	20	—	—	—	—	—
4000	50	—	20	—	—	—	—	—	—
8000	—	—	—	—	—	—	—	—	—

The above Table shows that:

- (1) the frequency of 250 Hz is not used by six of the regulations;
- (2) at 500 Hz, seven of the regulations accept a maximum loss of 20 dB, and two of the regulations a maximum of 30 dB;
- (3) at 1000 Hz, three regulations accept a maximum loss of 20 dB in each ear; two regulations, a maximum of 30 dB in each ear, and four regulations, a maximum of 20 dB in one ear and 40 dB in the other ear;
- (4) at 2000 Hz, the position is the same as for 1000 Hz;
- (5) at 3000 Hz, two regulations accept a maximum loss of 20 dB, one set of regulations accepts a maximum of 40 dB, and five regulations do not use this frequency;
- (6) at 4000 Hz, one set of regulations accepts a maximum loss of 20 dB, another set of regulations accepts a maximum loss of 50 dB, and seven regulations do not include this frequency;
- (7) the frequency of 8000 Hz is not used in any of the regulations.

3. *Transport Aircraft Pilots*

It also seems useful to compare the hearing standards imposed on *military* transport aircraft pilots with those laid down in the ICAO regulations for *civil* transport aircraft pilots.

TABLE 16

Comparative Table of Acceptable Hearing Loss Values
(transport aircraft pilots)

Frequency in Hz	Acceptable loss in decibels for each ear (Standards ASA 1951)									
	ICAO	France	Belgium	UK	Canada	Germany	US Army	US Navy	USAF	Norway
250	—	30	—	20	—	30	—	—	—	—
500	20	30	20 + 40	20	20	30	20 + 40	20 + 40	20 + 40	20 + 40
1000	25	30	20 + 40	20	20	30	20 + 40	20 + 40	20 + 40	20 + 40
2000	25	30	20 + 40	20	20	30	20 + 40	20 + 40	20 + 40	20 + 40
3000	40	40	—	20	20	—	—	—	—	—
4000	—	50	—	20	—	—	—	—	—	—

It will be seen that for this particular employment as pilot of a transport aircraft, the differences at the important frequencies of 500, 1000 and 2000 Hertz are so small that the military and civil standards can be assumed to be in agreement. At 3000 Hz and more, the differences are such that a comparison is no longer useful.

In conclusion, the variations disclosed in Tables 14 and 15 in regard to the hearing required to become a student pilot or a combat aircraft pilot show that pure tone audiometry which should, apparently, have helped to standardize hearing requirements in the NATO Air Forces has not in fact fully reached this objective.

On the question of the differences noted in the various regulations in the maximum acceptable hearing loss values at each frequency, these are sufficiently appreciable to form the subject of statistical studies and comparisons possibly leading to an attempt at standardization of the regulations in this field.

CHAPTER XVIII

CONCLUSIONS

Some conclusions or some evidence clearly discernible from the comparisons made between the assembled facts have been given at the end of each chapter or even sometimes after each major section of a chapter.

They will not be repeated here, the reader being left to refer back to them as necessary.

Other conclusions, much more general in scope, take shape if the field of consideration is extended beyond that of mere details.

- A. A considerable proportion of each of the regulations concerning fitness standards is devoted to purely administrative provisions. These are essential and unavoidable. As they are intended to permit the integration of the assessment decisions in a context appropriate to each Air Force, they clearly have a very specific character. For this reason such aspects have not been discussed in the present work, in spite of their considerable importance.
- B. The various regulations all follow the same structural plan.
 - (a) A few *positive* requirements expressed in very general terms: these consist in requiring the soundness of a particular function or major system of the body.
 - (b) A long list of malformations and diseases which are causes for permanent or temporary rejection.

Whenever possible, the pathological condition is indicated precisely by descriptive details or threshold standards of functional tests. Diagnosis of a disease and its probable development, the effect of flying on the latter, the effect of the pathological condition on flight safety and the subject's ability to perform his duties efficiently are all important factors to be taken into consideration by the examiner when arriving at his decision.

If, according to the well known saying, it is true that there are sick people in the world, but no sickness, it is no surprise to find variations in the steps to be taken in regard to candidates for flying training or fully trained aircrew who are suffering from, or who have suffered from, certain complaints.

Many of these differences have been noted in the comments of each chapter. Some, it is true, stem from traditional practices which die hard in some countries. Others however are justified by ethnic characteristics. Others, again, can be explained by the effect of climate, living and food habits, the pathology specific to certain geographical areas and the multiple ecological factors which affect the pathology of the various groups which make up the human race.

On reflection, it would seem nevertheless that many of these differences could be, if not eliminated, at least reduced. For example the *minimum* periods of temporary unfitness after certain surgical operations, or after certain injuries the normal development of which is well known, could be standardized to a greater degree, if the directives amplifying the text of the regulations could contain sufficient details on these precise points.

The anatomy and the physiology of the airman do not alter according to his nationality; the effects of flying on the human body and the sequelae of certain injuries and diseases do not conceal any mystery. There are therefore no really relevant reasons, at least on the strictly medical level, to justify very different decisions in regard to the same pathological condition, according to the nationality of the candidate for flying duties or of the serving airman.

- C. In three areas of the assessment of medical fitness, the main factor is the sum of *objective quantitative tests* and not the clinical description into which the personal opinion of the examiner can so easily introduce a subjective element.

The areas in question are:

- (a) the visual function;
 - (b) the hearing function;
 - (c) the biometric and skeletal requirements to ensure conformity with the dimensions of the cockpit.
- (a) With regard to the *visual function*, it would seem at first sight that the various objective aspects of its analysis should be capable of being reflected in minimum requirements as expressed by *numerical values* which are

identical in all the regulations. The present study has shown that this is not, in fact, the case, whether in regard to visual acuity, heterophoria or refraction. In addition, some aspects which can easily be measured precisely have not been mentioned in several of the regulations. Such omissions inevitably raise the question of the actual usefulness of the factors concerned and, consequently, the question of the interpretation to be placed on the relevant tests. A case in point is the distance perception test. The reason for the author's scepticism in regard to the justification for the stereoscopic test at the initial examination has already been sufficiently explained above. If there is any doubt about its value the question may be asked whether one is entitled to reject candidates for flying duty on such a basis, while the perception of distances by the trained pilot often involves, under actual operational conditions, mechanisms other than those introduced in the test.

A point by point review of the various aspects of the visual function in the flying duties, followed by a study on the significance of the tests for measuring them would therefore appear to be called for. It might be possible in this way to reduce the disagreements now evident in the comparative tables on the minimum visual acuity requirements and the acceptable maximum values for heterophoria.

- (b) For the *hearing function*, the problem is simpler. Excellent measuring instruments and techniques are available.

The problem is therefore one of agreement on the *frequencies* to be used for the audiograms recorded when assessing fitness, and particularly on the *hearing loss*, at each of these frequencies, which constitutes mandatory grounds for the rejection of the candidate, the elimination of the trained airman or the need of certain restrictions on his flying duties. It is a matter of flight safety. Since all the parameters are very well known ones, a greater degree of harmonisation between the regulations would not therefore appear to be an impossible task.

- (c) In regard to the *biometric and skeletal requirements* quoted in the regulations, some are imposed by the need to ensure that the pilot's measurements are suitable for the dimensions of the cockpit and of the ejection seat. With subjects of the same race, the minimum and maximum measurements compatible with safety should not differ greatly from one country to another.

Of these biometric requirements some are, however, related to the concept of a minimum robustness to be required from candidates for flying duties. Now, what is important in aviation is not so much muscular power as the individual's ability to withstand fatigue, the assaults which flying makes on his major physiological functions and the various stresses which the performance of his duties imposes on the control mechanisms of his physiology.

This ability cannot therefore be fully assessed on the basis of a *static* clinical examination and *morphological* data in which the main factors are weight and height, as still required under the current regulations in the Tables showing minimum acceptable weight and maximum acceptable weight in relation to height and age.

A true assessment can be obtained only by applying the appropriate standards from the functional point of view.

The systematic and strict application of morphological data of weight and height has meant that Air Forces have been deprived of quite a considerable number of candidates for training as pilots. It would therefore seem logical to disregard the excessive importance attached to the eliminatory character of these tables, and to subject candidate pilots, as a matter of routine, to an appropriate functional test to measure their actual degree of physical condition and resistance to prolonged stress, e.g. the Harvard five minute step-test. This test is practised in the Belgian Air Force. Subjects with a tendency to obesity sometimes find it difficult to pass the test: at least failures have a valid functional reason. Furthermore, a subject temporarily declared unfit after the test can hope to overcome his failure at a subsequent examination, if his motivation is strong enough, by following a carefully planned physical training course. As for subjects who are allegedly too thin according to the regulation tables, they can demonstrate in this way that, in spite of their thinness, they possess the normal capacity to withstand severe physical stress.

- D. On several occasions throughout his comments, the author has expressed the opinion that consideration should be given to a revision of some of the standards mentioned, in view of the discrepancies apparent in the regulations studied. These discrepancies arise from some ideas which belong more properly to the Air Forces of the past rather than to Air Forces of the present day.

This revision should, however, also give some thought to the already discernible lines of development of the Air Forces of the future.

Electronic equipment is being given an ever-increasing share of the work involved in flying all types of aircraft, and particularly combat aircraft. It neither eliminates nor reduces the part played by the human pilot or the aircrew. Far from it. It does, however, affect the relative importance of certain human factors which come into play when a pilot is controlling his aircraft. The sensory functions, and particularly the visual function, are a specific example.

Present day development in the design of combat aircraft may therefore affect the significance of morphological, physiological or sensory anomalies or insufficiencies, with the result that some of them may be felt to be less significant, and others more significant.

This very important concept must not be ignored during future revisions of medical fitness standards.

This critical and comparative review of nine sets of regulations has purposely laid great stress on any omissions, differences of opinion, or techniques of doubtful value which it is felt should be re-examined and investigated.

It highlights certain problems which require solution but it might possibly be reproached with not having given sufficient prominence to the problems — much more numerous — for which final solutions have already been found.

If emphasis has been placed on numerous special points of disagreement, it is because these must not be regarded merely as evidence of the survival of a tradition. They must also provide an opportunity for further thought on the significance of the theories applied, of the tests conducted and of the interpretation of the results of such tests. Some standard traditional concepts of the medical fitness examination may totter as a result, but this is often the way in which progress is achieved.

It is natural that the official texts, prepared with the full guarantee of official medical experts and with the approval of higher authorities, should give the users of such texts an impression of unshakable assurance and fully achieved perfection. Such an impression is always illusory to a certain degree.

The problems arising out of a comparison of the various medical fitness regulations are there as a reminder that these concepts are relative and constantly changing, and that there are a large number of subject matters in this field which still require further investigation by qualified researchers and experienced medical experts.

ANNEX 1

STANDARDS OF FITNESS FOR FLYING IN THE FRENCH ARMED FORCES

1. Standards for Initial Examination in the Air Force and in the Naval Aviation

<i>Function</i>	<i>SGA</i>	<i>SVA</i>	<i>SCA</i>	<i>SAA</i>
Candidate pilot, all categories	1A	2	1	1
Candidate transport pilot	1B	2	1	1
Candidate navigator-bomber-radar	2A	2	1	1
Candidate transport navigator	2B	3	1	1
Candidate crew engineer	2B	4	2	2
Candidate test parachutist	1A	2	2	1
Candidate flight nurse	2B	4	2	1
Candidate reserve military pilot	2B	3	2	2
Candidate observer air-gunner	2B	2	1	2

2. Standards for Periodic Examination in the Air Force and in the Naval Aviation

<i>Function</i>	<i>SGA</i>	<i>SVA</i>	<i>SCA</i>	<i>SAA</i>
Fighter pilot Reconnaissance pilot Bomber pilot (jet aircraft)	1A	3	1	2
Transport pilot Bomber pilot (conventional aircraft) Liaison twin engines pilot	2A	4	1	2
Helicopter pilot	2B	3	1	2
Liaison aircraft pilot Pilot of single engine aircraft for light support	2B	4	2	3
Reserve military pilot	2B	4	2	2
Instructor for elementary flying training	2B	4	1	2

<i>Function</i>	<i>SGA</i>	<i>SVA</i>	<i>SCA</i>	<i>SAA</i>
Navigator-bomber-radar	2A	3	1	2
Transport navigator Radio-navigator	2B	4	2	2
Radio-operator	2B	5	2	2
Observer air-gunner Crew-refueller	2B	3	2	2
Crew engineer	2B	5	2	2
Test parachutist	2A	3	2	2
Flight nurse	2B	5	2	2

3. Standards for Initial Examination in the Light Aviation of the Army and in the Flying Personnel of the Gendarmerie

<i>Function</i>	<i>SGA</i>	<i>SVA</i>	<i>SCA</i>	<i>SAA</i>
Candidate observer	2B	3	2	2
Candidate aircraft pilot	2B	3	2	2
Candidate helicopter pilot	2B	3	2	2
Candidate observer-pilot	2B	3	2	2
Candidate crew engineer	2B	4	2	2

4. Standards for Periodical Examination in the Light Aviation of the Army and in the Flying Personnel of the Gendarmerie

<i>Function</i>	<i>SGA</i>	<i>SVA</i>	<i>SCA</i>	<i>SAA</i>
Observer	2B	4	2	3
Aircraft pilot	2B	4	2	3
Helicopter pilot	2B	4	2	3
Observer pilot	2B	4	2	3
Crew engineer	2B	5	2	3

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